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Torque loading a motor starter of a type which is standard equipment on many military aircraft. A hydraulic test rig is used so that the cover can be screwed down to a pre-determined load. (*Nurnberg photograph for* ENGINEERING)

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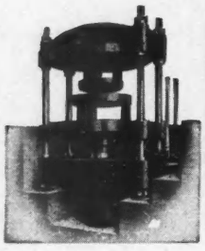

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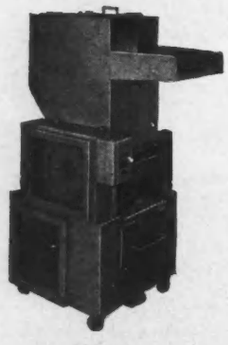

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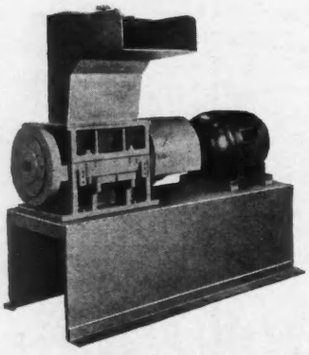

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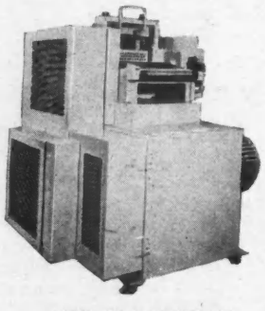

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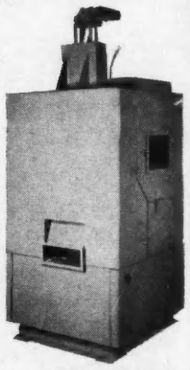

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ENGINEERING Impact

of Plastics Soberly Assessed

Two of the articles which appear in this issue on the subject of plastics were commissioned with a definite aim: to encourage established engineering firms or suppliers to set up their own plastics departments. In a sense this aim has gone astray, in that the recommendation of both English Electric Company and Stewarts and Lloyds Plastics is to leave the job of fabrication in plastics to a specialist firm. In other words, it is not necessarily wise for an engineering firm to establish its own plastics department.

To highlight some of the comments from these articles, Mr. Hayes of English Electric says that even if an engineering firm uses the services of a plastics firm, it is wise to employ a liaison engineer who "should have a wide knowledge of reinforced plastics so that some of the many pitfalls can be avoided. . . . The English Electric group was fortunate, because the basis of the division already existed in the form of a large department previously engaged on aircraft work. However, it has been found that there is an acute shortage of technical personnel with experience in this industry."

In parallel comments on the plastic pipe industry, Mr. Mange of Stewarts and Lloyds Plastics writes: "If the use of plastic pipe is to develop satisfactorily in the UK, it is essential for the manufacturers to understand the requirements of the industries they desire to supply. There is an unfortunate tendency in some cases to think that all that is necessary is to buy an extrusion machine and some polymer and start extruding pipe. This is by no means the case."

It is probably unwise to look on such remarks as mudslinging between different parts of the plastics industry. It is more constructive to look on them as self-appraising comments from companies with established backgrounds in the engineering world, who want to make sure that the right material is used for the right job without anyone's reputations being damaged. As Mr. Hayes points out, "It is our experience that the claims of the raw material manufacturers tend to err on the optimistic side."

Growth of International Power Links

"Those in the rear cried Forward! and those in the front cried Back!": this seemed to sum up the attitude of the delegates to the twelfth congress of the International Union of Producers and Distributors of Electrical Energy, held in October at Baden-Baden, when the subject of international connections came under discussion.

Those at the front—engineers concerned with what were frequently called the "great interconnections"—were seen as advocating caution in planning new lines: but those at the back had a different view. With no disrespect, those at the back were the engineers from countries where complete extra high voltage *internal* interconnection has not yet been achieved. In a survey by P. W. Cash and D. R. Stevens, of the United Kingdom Central Electricity Generating Board, it was seen that practically every European country was pressing towards the goal of a complete 380/400 kV supergrid, able to link together the energy resources in the country itself and, if needed, to link together adjacent national networks. In some cases this policy was being pursued by building lines that could operate efficiently first at a lower voltage, say 220 kV, and could later be converted to 380/400 kV as easily as possible. This conversion question was in fact, the theme of the paper, and it was interesting to note that total capital costs were from 1·5 per cent to 16·5 per cent less for lines built for operation at the final voltage than for lines built for a lower voltage but with possibilities of later conversion.

One of the directors of what is perhaps the largest overhead line construction company in Europe, who happened to be present at the Baden-Baden conference, admitted privately to ENGINEERING: "I've heard all this before. Whatever shape the future takes, there must be large power stations in relatively small numbers, within any territory, and large amounts of power must be transmitted. We don't really care if we sell large numbers of short lines or small numbers of long lines . . ."

Very Much Better for Being Late

A happier prospect is now apparent after the gloomy reflections following the dropping of the Q3, the Cunard Company's replacement for the Queen Mary. The immediate reaction was almost entirely one of bitter criticism of Cunard themselves and of the Government who had promised to subsidize the ship to the extent of £18 million. Now that the first wave of discontent has broken, there is a calmer atmosphere in which to view the future.

First and foremost is the comment that it was better to take the decision late than too late. Indeed the very lateness of the decision, after the tenders had been examined and the best selected, may prove to be the best feature of all. The designs and building techniques were analysed and costed in all the country's major shipyards. The "successful" tender came from the consortium of Vickers and Swan Hunter; their tender, even allowing for escalator clauses, was the lowest and below the limit of £30 million imposed by the Cunard line. Mr. John Hunter, chairman of the consortium, has made it quite clear that the bid was made on a normal competitive basis, including a proper allowance for profit. Now it is one thing to attempt a design on the assumption that a target price can be met, but quite another thing to know that it has been met elsewhere. There is likely to be some very thorough reassessment of building techniques in the "unsuccessful" shipyards and that cannot be without benefit. After all, if a tender is lost and the project carried through by the successful bidder, the losers have lost. In this case, however, everyone is going to be able to tender again.

The Cunard line are going to reconsider the matter next spring. That it is a real commercial proposition to put a new, fast, super luxury vessel on the North American run, there can be no doubt: there will always be a hard core of wealthy patrons who will enjoy four or five days by sea and pay well for the privilege. Cunard are bound to reach the same conclusion as in the past—that a new ship is a sound investment—and they will be six months nearer the end of the Queen Mary. The big shipyards learnt a lot in the last six months; they have all got six months to find out more and a smaller vessel may well bring some new yards into the competition. It *is* certain that the bidding will be fiercer, and the Q4 a better ship than the Q3 would have been.

of Making the Men Go Round

Is the scientific and technical manpower at present available being utilized in the most effective manner?

Sir Kenneth Hague asked the question in his presidential address to the Institution of Mechanical Engineers. He answered it by saying that in his opinion most engineers of long experience would agree that it was not. He then gave some good advice to firms with research problems. As far back as 1946 Sir Harold Hartley had put the question "were there any golden rules for research in industry?" and Sir Kenneth quoted Sir Harold's own answer that the first was a sympathetic chairman and board of directors with imagination and continuing interest.

Where there were several companies operating within a group it was the sensible thing to arrange the research among them so that there was no overlapping and concentration of suitable ability. Single companies were advised to make more use of the National research organizations already in existance. The objections that the work might not be sufficiently secret had little weight in these days, when many firms found it better to utilize an idea without waiting to secure a patent.

As the ultimate challenge, the President quoted a statement made by Sir Henry Tizard "The real need is for men of scientific education who have the outlook of the engineer rather than of the pure scientist". He concluded that to use the available manpower best, there must be some streamlining of research, more discussion of projected researches at the national establishments, and more practical training for those who take up research work.

Providing a Service

When used in the same context as the sustained successful selling of any engineering product, the word "service" has two separate and distinct meanings. Service of the after-sales kind is certainly important, and its nature varies considerably from one kind of product to the next; but it is the other more subtle meaning, characterized by the use of the indefinite article, that may be less clearly understood.

Close investigation into the factors behind success in the engineering industry in terms of good reputation and a healthy sales position reveals that the philosophy of selling a service and not just a product is perhaps more vital to the manufacturer than is generally realized.

Suppose for instance that X is a manufacturer making excavators. A contractor, facing an excavation problem that in all probability will re-occur, decides that the time is ripe to invest in a new machine. All he is concerned with is getting the job done at the best return to himself and finishing up with a machine potentially useful for later contracts. But he is unlikely to be in a good position to decide which make and model to buy without specialist advice. Naturally he is more likely to purchase from a firm willing to send skilled representatives to meet him on the spot and bring a high degree of specialist knowledge and experience to bear on his problem.

Suppose that X does so and gets the order. In the fullness of time the same contractor will, if he is successful, want to order more machines to cope with expanding business—a situation to which the original excavator will have contributed. He will have the choice of either going back to X or trying another manufacturer. Many factors will influence his decision, but uppermost in his mind will be the question, how well did X treat him both before and after the guarantee period expired on his first machine? Did the firm lose interest in him, or was he made to feel that their advice and assistance was always at his disposal, thereby ensuring reasonable continuity of the facility he had purchased?

One fact stands out clearly: to sell "a service" means putting oneself in the customer's position and seeing things from his point of view.

and of Buyers' Desires to be Bright and Gay

Colour is the predominant overtone to styling, whether it be engineering product, clothes or women—blonde, brunette or redhead. However much repeat orders may depend on service, colour is vital to the first sale. Taking into account prices and the numbers involved, and neglecting the women, cars represent as good a measure as any of the selling power of colour.

During the London Motor Show, the Paints Division of Imperial Chemical Industries have carried out their annual investigation of colour trends. Despite the outstanding splashes of blue and red, the count shows that ivories, creams and greys are still the most common single colours: of the 155 cars in single colours, 66 were painted in these shades, which were also used on many of the duo-tones, though often paired with a contrasting bright colour. Reds and blues easily outstrip any other colours but, individually, there are several striking and attractive greens, maroons and yellows. Fawns are more noticeable than last year. Lavender, a feature of last year's show, is virtually absent—thank goodness not many engineering buyers are women. Black is still insignificant as a single colour.

If the Show indicates the popular trends, and if the indications are of a wider significance than motor cars alone, colours will become more varied than ever. So varied in fact, say ICI, that it will become necessary to adopt a more comprehensive method of colour classification.

Packaged Stabilizer Takes Less Space

The prototype of a new design in ship stabilizers has been fitted to the BTC's "Caledonian Princess". The stabilizer is withdrawn by rotating, thus saving space, and is also easily fitted as a packaged unit.

A SHIP'S stabilizer, which instead of being withdrawn by sliding athwartships into the hull, rotates through 90° into the hull and lies in a fore and aft position has been fitted in the British Transport Commission vessel "Caledonian Princess."

These stabilizers are the prototype of the latest activated fin stabilizer, the design of which has been developed through the association of the Scottish and German shipbuilding firms, Brown Brothers and Company Limited, William Denny and Brothers Limited, AEG and Deutsche Werft in Hamburg. The new stabilizer is accordingly known as the " Denny-Brown-AEG" and the gyro control equipment is similar to that supplied for the conventional type stabilizers.

The main advantage of the new stabilizer is, as can be seen from the drawing, that some athwartship space can be saved. As a stabilizer is normally most effective when fitted at the ship's maximum beam, the makers claim that the new stabilizer may show advantages over the conventional type when an existing ship has to be stabilized as less athwartship space in the main engine room may be used.

It is obviously an advantage to limit the number of working parts of a stabilizer which have to be exposed to sea water to the minimum, to reduce maintenance in drydock. Most working parts of the new design have been encased in an oil tight casing.

The operating mechanism for tilting the fins to stabilize the ship is a rotary vane unit built inside the fin. It is basically similar to that used on AEG's electro-hydraulic rotary vane steering gear system, and was supplied by AEG. The finshaft is only subjected to bending forces, as the fin rotates about the finshaft and not with it. The stabilizer fins, which are in principle of the standard Denny-Brown type, are each made in two pieces, the main part tilting about the centreline of the finshaft and the tail portion tilting relatively to the main fin. These fins are so controlled that as the ship rolls, its velocity causes the water to exert forces on the fins providing a righting couple against the rolling motion of the ship. The amount of tilt on the fin is decided by the gyro control gear which measures the roll angle, roll velocity and roll acceleration of the ship and, through electric and hydraulic amplifiers, controls the main pumps which tilt the fins.

Power for tilting the fins is supplied by two electric motor driven VSG variable delivery pumps, one for each fin. These pumps deliver oil under pressure to the vane units previously mentioned, which are fitted inside the fins. A separate auto-controlled VSG pump supplies power for housing and extending the fins and also for operating the hydraulic servos between the gyro control gear and the main pumps.

Timken taper roller bearings locate each fin on its finshaft and the fin is oscillated by the vane motor through a flexible drive. The tail portion of the fin is moved relative to the main fin by a rack and quadrant mechanism. All of this equipment is encased and is sealed from the sea by a Simplex seal manufactured by Deutsche Werft, and lubrication is effected by pressure from a header tank located above sea level. The whole fin assembly is carried in a crux which has, integral with it, an upper and lower trunnion pin acting as the main pintle for rotating the fins into the housed position. These trunnions are carried in bushed brackets securely bolted to the finbox, the upper bracket acting as the sea gland through which the fluid supplies are led. The upper bracket also incorporates the steadiment for transmitting the vertical loads to the hull.

From the photographs it can be observed that little fitting work and erection is required to install this type of equipment as the whole assembly, including the finboxes, can be supplied as a packaged unit ready for welding into the hull. The fin assembly has been arranged so that the complete fin unit, including the finshaft, can be easily withdrawn from the crux for servicing purposes.

Bridge control of the stabilizers is similar to other Denny-Brown units and consists fundamentally of three hand-operated switches:

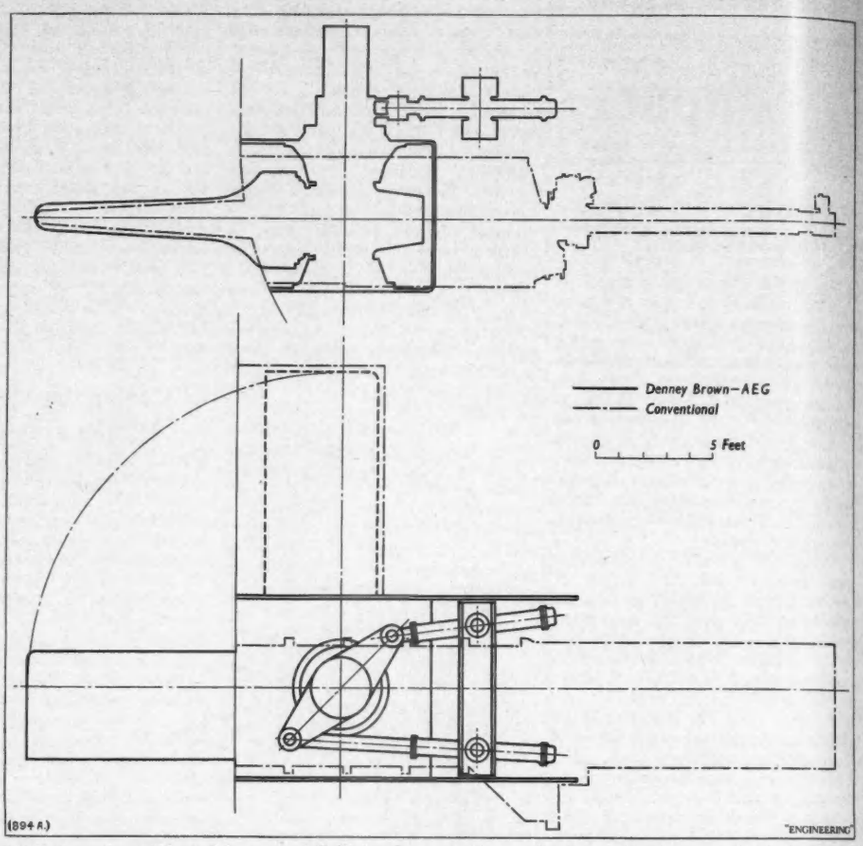
(*a*) One switch to signal the order to start up the various motors;

(*b*) One which extends and houses the fins;

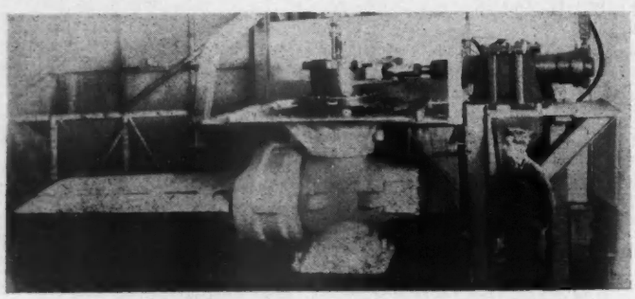
(*c*) One which starts or stops the fin stabilizing mechanism.

The position of the fins and other features can be observed at the bridge by indicator lamps. A fin angle indicator lamp which shows movement of the fin when stabilizing is also mounted in the bridge control panel. The main dimensions of the fins are 7 ft 10 in long by 4 ft wide and the area is 31½ sq. ft.

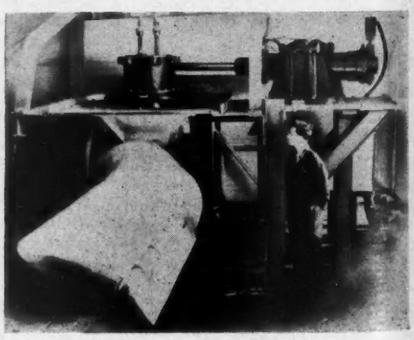
Brown Brothers and Company Limited, Rosebank Ironworks, Edinburgh 7.



With the new stabilizer (shown in full line) some space is saved athwartships because the fin is rotated into the hull and lies in a fore and aft position. The conventional stabilizer is shown in chain dotted line.



Little fitting and erection work is required to install this stabilizer into an existing vessel as the whole of the equipment, including the finboxes, can be supplied as a packaged unit ready for welding into the hull.



Epicyclic Gears for Merchant Ship Propulsion

Many owners of the steam-powered Liberty ships in seeking a better overall performance are converting to diesel propulsion. In France, Ateliers et Chantiers de Bretagne have been carrying out the conversion of a number of single-screw Liberty ships.

For two of these ships—belonging to Zim Israel Navigation Company Limited—two identical Allen-Stoeckicht main propulsion epicyclic gears are being supplied. Designed to transmit 4,200 hp continuously with a speed reduction of 418/128 rpm, they represent the largest Allen-Stoeckicht epicyclic gears yet made for merchant ship propulsion.

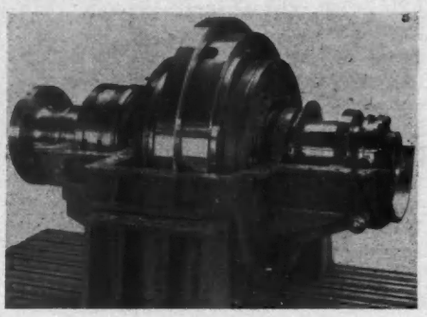
The two ships, to be renamed Pan and Velos, have displacements of 12,000 tons and each will be powered by a 4,200 hp ACB/Pielstick reversible 12 cylinder engine driving through a fluid coupling and epicyclic gear, the slow speed shaft of which is solidly bolted to the propeller shaft. Re-powering at minimum cost thas been made possible by simply removing the old steam engine and replacing it by the geared diesel plant.

Because of the compactness of the epicyclic gear and the coaxial arrangement of the input and output shafts, it has been possible to carry out the conversion without moving the existing boilers. This in turn has resulted in retaining the existing auxiliaries.

The gear, which has been designed on a long-life basis to the requirements of Bureau Veritas, is of exactly the same type as that which would be offered for steam or gas-turbine main propulsion and would be suitable for use at much higher speeds, at which the horse-power transmitted would be correspondingly increased.

The sunwheel is connected to the fluid coupling by a double-toothed flexible coupling, the input flange of which is carried by the fluid coupling. The six planet wheels revolve on whitemetal-faced spindles and are driven by the floating sunwheel. The annulus system is flexibly coupled to the gearcase and the drive is transmitted through the planet wheels to the rotating carrier which is rigidly bolted to the output shaft. A single solid-forged collar on the output shaft, transmits the propeller thrust of 50 tons by a Michell thrust bearing. The sun and planets are hardened by the nitriding process.

At the input end, provision is made for turning gear. A small geared motor is used through a pair of straight bevel gears and a manually operated dog clutch which engages with the coupling flange.



The largest Allen-Stoeckicht epicyclic gear yet built for merchant ship propulsion.

W. H. Allen Sons and Company Limited, Queens Engineering Works, Bedford.

Second of Three Drakelow Power Stations Opened

By the end of 1966, Drakelow Estate, four miles south of Burton-on-Trent, will be the site of three power stations with an aggregate capacity of well over 2,000 MW—the largest concentration of power generation in Europe. It is one of several sites that the Central Electricity Generating Board are currently developing to exploit the low quality coal of the East Midlands coalfield.

Drakelow B, with a capacity of 480 MW, has now been opened and its output is twice that of A station opened in 1955, but only a third of C station on which construction work started last year. B station cost £23 m to build.

Steam power station plant varies little in the essentials between one station and another, the principle variations occurring in the size of the generating units, the steam conditions and the layout. Drakelow B has four 120 MW units with steam conditions at the turbine stop valves of 1,500 lb per sq. in at 1,000°F, re-heated to 1,000° F at 360 lb per sq. in between the high and intermediate pressure turbine stages.

The four pulverized-fuel-fired single drum reheat boilers each have an evaporative capacity of 860,000 lb per hr and are structurally integrated with the building framework. That for the first (No 5) unit was supplied by International Combustion Limited and those for Nos. 6, 7 and 8 unit by Foster Wheeler Limited. Apart from having a different arrangement of pressure parts, No. 5 boiler also differs from the remainder in steam temperature control and the method of firing. On No. 5 the main super-heater temperature control is by an interstage spray desuperheater, with reheat temperature control by tilting burners arranged in the four corners of the furnace, supplemented by hand operated by-pass dampers for coarse control. Five vertical roller mills are provided of which four are required on full load.

Nos. 6, 7 and 8 boilers have superheater condenser control effected in the headers between the drum and the radiant superheater. Reheat temperature control is by a system of dampers in the reheater section. The pulverized fuel plant comprises three double-ended ball mills each with two exhausters, and two mills can maintain full load when using coal with reasonable low moisture and ash content.

All boilers have two rotary regenerative pattern air heaters, two FD and two ID fans, and centrifugal dust collectors and electrostatic precipitators.

Instead of being mounted high up in front of the boilers, the coal bunkers are placed between each pair of boilers with the bunker outlets at firing floor level—an arrangement which imposes a certain space requirement between the units but offers important economies in the building structure.

The four alternator sets were supplied by C. A. Parsons and Company Limited and are arranged longitudinally. Each comprises a three-cylinder impulse-reaction turbine with the low pressure cylinder arranged for triple flow, direct coupled to a 3,000 rpm hydrogen cooled alternator. The main speed governor controls the high pressure steam admission valves and an independent auxiliary governor controls the intercept and unloading valves. The auxiliary governors can be set independently of the main governor.

With the completion of C station in about five years' time, the plant in the three stations will represent three stages in the general advance in design and construction of power generating equipment of the last decade.

Construction Sets for Instruction and Development

Automat engineering sets, which are said to be the bridge between theory and practice, are now available in this country. The sets, which are Swiss in origin, are made up of precision-engineered elements for assembling any desired combination of motions and mechanisms, and are suitable for constructing models of such things as automatic machines and recording instruments for the purpose of demonstration and development.

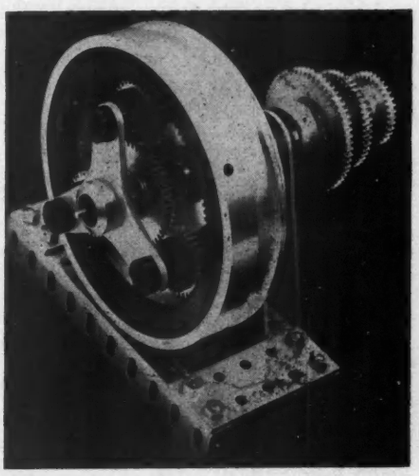
Set No. 1, for instance, is classed as a beginner's set with 316 parts which aims to teach the basic knowledge of gear trains and also to provide an introduction to metal working on a lathe. With this set, various gear boxes can be built which demonstrate in three dimensional form the concept of gear wheels, the calculation of the module and outside diameters, the centre distances, the number of revolutions and ratios of simple and compound gear trains. In addition, parts are supplied for building a demonstration model of a simple lathe, complete with gear quadrant and leadscrew, for explaining problems met when varying the advance, change gears and cutting speeds.

Set No. 25 is recommended for students in classroom and home, while set No. 33 is intended for teachers, training instructors and young engineers. To meet the more advanced requirements of technical and scientific research, a specially comprehensive set is offered, No. 1500. With this set, ways and means of improving existing machines can be devised. Stresses and bending moments, which otherwise might only come to light on the finished machine, can be recognized on the miniature model in time to be taken into consideration when designing the full scale machine.

Set 1500 contains 4,000 components laid out in a well organized manner in five separate trays. Among the parts are spur gears, planetary gears, couplings and clutches, intermittent motions, cam mechanisms, bearings, leadscrews and springs. Typical of the items contained in this set is the planetary gear which is illustrated. This model, which is 110 mm outside diameter, has a gear rim of 108 teeth, a sun of 48 teeth and three planets of 30 teeth each.

Automat sets are available in this country from

International Engineering Concessionaires Limited, 39 Parliament Street, London SW1.



110 mm o/d planetary gear contained in Set 1500.

XUM

Plain Words

By Capricorn

THANK your lucky stars you are living in the Age of Advice. Everywhere there are people waiting to advise you, willing to advise you, wanting to advise you. When life seems intolerable, just think of all those nice, kind folks to whom you can turn with your problem.

In engineering, the oldest branch of the advising profession are the consulting engineers. They have attained to such a degree of respectability that they don't advertise, they hardly ever publicize, and they are aloofly independent. If you are an engineer with a non-engineer for your chief, you may have some difficulty in explaining to him why you have to call in another engineer to do your job. Take heart, though; your best line of attack is to let him choose between paying a consulting engineer a fee for a finite term of service, or allowing you to enlarge your department—which, as every Parkinson pupil knows, is the surest way of running the company into a deficit.

By contrast, the new boys in the Age of Advice are the management consultants. They have been operating for many years, but they have blossomed out so much in the last few years. In one day they can put their fingers on more things that are wrong in your company than you could discover in a year by yourself. Fortunately, they have acquired the knack of telling us these home truths acceptably. We even go round bragging that the major reorganization which saved the old firm was actually our idea. The management consultant doesn't mind: he charges a fee.

In the big, wide world outside engineering, advisers abound. There are people to advise you on buying vegetables for the weekend, choosing between all the makes of washing machines, increasing the collections at the parish church, selecting a profession for your son, and laying out the garden, as well as such simple problems as filling in an income tax return or choosing a wife.

Most of them make a charge for their services, but if you like to do things on the cheap there is an even greater number of people who will advise you free on any problem at all so long as they don't have to take the responsibility for the consequences.

It's the Age of Advice, without a doubt. Must I accept it? Must I turn to some expert on every possible occasion? Have I no mind of my own? I have had enough of all this advice. In future I will make my own decisions. I won't listen to advice. . . .

Thus is born a dictator—the man who reserves the power of decision so often to himself that he has no time to listen to advice. A decision-maker who has deprived himself of the raw materials of decision-making.

I will take advice. And I will give it, too. In place of a good old-fashioned command to do this or that, I will use that gentle formula which makes advisers of us all: " Mr. Smith, would you *mind* doing this?"

Letters to the Editor

The Risk of Taking a Risk

SIR, Your comments in Impact on the risk of taking a risk (ENGNG., 13 Oct. '61, p. 461) are very useful but, I suggest, they neglect the need for training in road behaviour before taking up motoring.

This is clearly necessary for pedestrians, for it is as such that road habits are first learned, and the early inculcation of a respect for the rule of the road and the highway code must be the best training for good road behaviour in all roles.

The almost totally undisciplined behaviour of pedestrians in Britain, and the evident official acquiescence in this, make it really surprising that the motorist's discipline is as good as it is.

How much better might it be if everybody learned, for example, to keep to the left, from the first day they started to use the roads.

Yours faithfully,
P. F. Foss.

Godalming,
17 October, 1961.

More Comfortable Bogies

SIR, Your correspondent, Mr. H. L. Lloyd, in his recent letter (ENGNG., 15 Sept., '61 p. 334), questions whether the large central bearing, a feature of the Commonwealth bogie, will decrease the period of oscillation.

Mr. Lloyd apparently thinks that this is something to be desired. Decreasing the period of oscillation would be undesirable and we make no such claim for our central bearing.

What the central bearing does is to damp swivelling oscillations of the bogie, thereby reducing the frequency and magnitude of such oscillations; this, in turn, causes a marked improvement of the riding qualities of the vehicle and greatly increases the wheel life between turnings.

The central bearing requires no side bearings. It also eliminates centre plate lubrication.

Reducing the swivel resistance by means of ball bearings or roller bearings is undesirable because that reduces the damping of the swivelling oscillations. Ball bearing type slewing rings are not new. Several were shown in the 1912 Carbuilders' Dictionary in the United States, but we do not know of any now being used on American railway vehicles.

We hope that the above explanation of the function of the large central bearing feature of the Commonwealth bogie will remove any misunderstanding which may exist on the part of any of your readers.

Yours faithfully,
C. J. DADSWELL,
Manag ng Director.

English Steel Castings Corporation Limited,
Sheffield 9.
18 October, 1961.

Events in Advance

Machine Tools on Show in London

VISITORS will be able to view an extensive and interesting range of new machines for toolroom and production—many of them have not previously been on show anywhere—at the private exhibition of machine tools which is being arranged by SOAG Machine Tools Limited at their showrooms, Hester Road, Battersea, London SW11, from 15 to 24 November next.

It is the firm's intention that all these machines shall be properly demonstrated and a team of their own specialists, as well as experts from their suppliers' works, will be available throughout the period of the display to explain the latest devices incorporated in these machines and to give technical advice.

Of special interest will be the Contelyt-Cadet and Contelyt model PH175 electrolytic grinding machines for the economic sharpening of carbide tools by the electro-chemical process. These machines are made in Switzerland by Maschinenfabrik Aargau, who, by building their own generators into the base of each model, have been able to simplify and improve the designs of the machines, and thereby, to achieve greater efficiency.

Among the many other machines to be exhibited may be mentioned an Ajax radial drill, a range of Dansk power presses having a capacity ranging from 24 to 100 tons, two Elb surface grinding machines, a Hoerster rotary table surface grinder, a range of Dydromatic air presses, an M.R. and P.-Torrington spring coiling machine, two Mondiale production lathes and a Pedersen universal miller and universal tool and cutter grinder, as well as various Ortlinghaus clutches and gear units.

There will also be a range of Scantic plate bending rolls, Sala cutting-off machines and a Skandia 8 ton power press. Additional particulars regarding the machines to be on show and other information may be obtained from the firm's head office, Juxon Street, Lambeth, London SE11, or by telephoning RELiance 7201.

Exhibitions and Conferences

Arranged in chronological order

British Junior Chambers of Commerce, National Conference.—Fri. and Sat., 27 and 28 Oct., at the Prince of Wales Hotel, Southport. Theme: " Education for Management ". Organized by the North West Regional Group of the British Junior Chambers of Commerce, 68 Queen Street, London EC4. Telephone CITy 7211.

SOAG Exhibition of Machine Tools.—Wed., 15 Nov., to Fri., 24 Nov., organized by SOAG Machine Tools Ltd., at their showrooms, 22 Hester Road, Battersea, London SW11. Apply to the company's head office: 7 Juxon Street, Lambeth, London SE11. Tel. RELiance 7201.

Imperfections in Crystals, Conference.—Fri. and Sat., 17 and 18 Nov., at the Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London SW1. Organized, as their autumn conference, by the X-Ray Analysis Group of the Institute of Physics and the Physical Society, 47 Belgrave Square, London SW1. Tel.: BELgravia 6111.

Efficiency in the Office, One-Day Conference.—Thurs., 23 Nov., at the Connaught Rooms, Great Queen Street, London WC2. Organized by the British Institute of Management, 80 Fetter Lane, London EC4. Tel. HOLborn 3456.

Camping and Outdoor Life Exhibition, Fourth National.—Tues., 2 Jan., to Sat., 13 Jan., 1962, in the Empire Hall, Olympia, London W14. Organized by Trades Exhibitions Ltd., Exhibition House, Spring Street, London W2. Tel. AMBassador 5421.

Boat Show, Eighth National.—Wed., 3 Jan., to Sat., 13 Jan., 1962, at Earls Court, London SW5. Organized by the Ship and Boat Builders National Federation, 23 Knightsbridge, London SW1. Tel. BELgravia 6402.

Special Heat Exchanger Equipment, One-Day Symposium.—Tues., 9 Jan., 1962, in Manchester. Organized by the North Western Branch of the Institution of Chemical Engineers. Apply to Mr. Michael Shaw, Project Constructors Ltd., Shepley Works, Audenshaw, Manchester.

Reliability and Quality Control, Eighth National Symposium.—Tues., 9 Jan., to Thurs., 11 Jan., 1962, at the Statler-Hilton Hotel, Washington, DC, USA. Sponsored by sections of the American Society for Quality Control, the American Institute of Electrical Engineers, and the Engineering Department of the Electronic Industries Association. Information obtainable from Mr. M. P. Smith, Aeronautical Division, Minneapolis-Honeywell Regulator Co., 13350 US Highway 19, St. Petersburg, Florida, USA; and from Institute of Radio Engineers, 1 East 79th Street, New York 21.

Toy Fair, International.—Sat., 13 Jan., to Fri., 19 Jan., 1962, at Harrogate. Organized by Harrogate International Toy Fair Ltd., Finsbury Pavement, London EC2. Tel. MONarch 8921.

Meetings and Papers

The address and telephone number of the headquarters of each institution are given at the end of this list. Meetings in the headquarters towns are held there unless otherwise stated.

Association of Supervising Electrical Engineers

MANCHESTER
"Static Switching Control Systems," by B. A. W. Midgley. Offices of the North Western Electricity Board, Town Hall Extension, St. Peter's Square, Manchester 2. Wed., 1 Nov., 7.30 p.m.

British Association for Commercial and Industrial Education

LONDON
"Training in the United Kingdom for Personnel from Overseas," by J. L. Stanton and Michael Collins. Caxton Hall, off Victoria Street, SW1. Tues., 7 Nov., 2.30 p.m.

British Institution of Radio Engineers

LONDON
"Electronics in Chromatography," by E. L. Gregory and E. A. Piper. Medical Electronics Group. London School of Hygiene and Tropical Medicine, Keppel Street, WC1. Wed., 8 Nov., 6 p.m.
CARDIFF
"High-Frequency Induction Heating and Dielectric Heating," by W. D. Wilkinson. South Wales Section. Welsh College of Advanced Technology, Cardiff. Wed., 8 Nov., 6.30 p.m.
EDINBURGH
"Ultra-High-Speed Photography," by W. A. Jones. Scottish Section. Department of Natural Philosphy, The University, Drummond Street, Edinburgh. Wed., 8 Nov., 7 p.m.
GLASGOW
"Ultra-High-Speed Photography," by W. A. Jones. Scottish Section. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow C2. Thurs., 9 Nov., 7 p.m.

Building Centre

LONDON
"Trade Literature for the Building Industry": Discussion, opened by Andrew Derbyshire and R. B. Caws. Wed., 8 Nov., 6 p.m.

Combustion Engineering Association

GLASGOW
"Design and Installation of Industrial Boiler Plants"; Discussion, opened by A. F. Webber. Grand Hotel, Charing Cross, Glasgow, Wed., 8 Nov., 10 a.m.

East Midlands Metallurgical Society

DERBY
"Electron Beam Welding," by M. Harper. Derby and District College of Art, Derby. Thurs., 9 Nov., 7.30 p.m.

Illuminating Engineering Society

LONDON
"Changes in the Dimensions of Incandescent Lamps," by A. G. Penny; "A Standard Heat Test Lamp for the Temperature Testing of Lighting Fittings," by J. N. Bowtell and J. R. Coaton; and "Temperatures in Lighting Equipment with Incandescent Lamps," by J. Keen and H. F. Stephenson. Federation of British Industries, 21 Tothill Street, SW1. Tues., 14 Nov., 5.30 p.m.
MANCHESTER
"Lighting for Christmas," by E. P. Lee. Manchester Centre. Offices of the North Western Electricity Board, Town Hall Extension, St. Peter's Square, Manchester 2. Thurs., 9 Nov., 6 p.m.
SHEFFIELD
"The New IES Code," by H. E. Bellchambers. Sheffield Centre. Grand Hotel, Sheffield. Mon., 13 Nov., 6.30 p.m.

Institute of Marine Engineers

LONDON
"Construction of the Ship," by G. Ridley Watson. Junior Lecture. East Ham Technical College, Barking Road, E6. Tues., 7 Nov., 7 p.m.
GLASGOW
"Development of Heavy-Duty Marine Diesels During the Past Five Years," by Dipl. Ing. W. Kilchenmann. Scottish Section. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow C2. Wed., 8 Nov., 7.30 p.m.
LIVERPOOL
"Observations on the Design and Construction of the N.S. Savannah," by J. A. Dodd and S. Macdonald. Merseyside and North Western Section. Liverpool Engineering Society, 9 The Temple, 24 Dale Street, Liverpool. Mon., 6 Nov., 6 p.m.

Institute of Metals

BIRMINGHAM
"The Welding of Metals," by D. R. Thorneycroft. Birmingham Local Section. College of Advanced Technology, Gosta Green, Birmingham. Thurs., 9 Nov., 6.30 p.m.
OXFORD
"Bearing Materials," by P. G. Forrester. Oxford Local Section. Cadena Café, Cornmarket Street, Oxford. Tues., 7 Nov., 7.15 p.m.

Institution of Agricultural Engineers

ABERDEEN
"Materials Handling on the Farm," by I. J. Fleming. Scottish Branch. Robert Gordon's Technical College, Schoolhill, Aberdeen. Thurs., 9 Nov., 7.30 p.m.
LANARK
"Materials Handling on the Farm," by I. J. Fleming. Scottish Branch. Silver Bell Restaurant, Bannatyne Street, Lanark. Wed., 8 Nov., 7.30 p.m.

Institution of Civil Engineers

LONDON
Presidential Address, by Sir George McNaughton. Tues., 7 Nov., 5.30 p.m.
"Structural Problems in the Use of Cold-Formed Steel Sections," by A. H. Chilver. Tues., 14 Nov., 5.30 p.m.

Institution of Electrical Engineers

LONDON
"The General Problems of Multi-Channel Communications," by R. G. Medhurst. Electronics and Communications Section. Mon., 6 Nov., 5.30 p.m.
"Tracking in Insulation," by N. Parkman. Measurement and Control Section. Tues., 14 Nov., 5.30 p.m.
ABERDEEN
"Thermistors: Their Theory, Manufacture and Application," by Dr. R. W. A. Scarr and R. A. Setterington. North Scotland Subcentre. Robert Gordon's Technical College, Aberdeen, Fri., 10 Nov., 6 p.m.
BIRMINGHAM
"A Dynamic Model for Studying the Behaviour of the Overhead Equipment Used in Electric Railway Traction," by D. S. Farr, H. C. Hall and Dr. A. L. Williams. South Midland Centre. James Watt Memorial Institute, Great Charles Street, Birmingham. Mon., 6 Nov., 6 p.m.
DUNDEE
"Thermistors: Their Theory, Manufacture and Application," by Dr. R. W. A. Scarr and R. A. Setterington. North Scotland Subcentre. Electrical Engineering Department, Queen's College, Dundee. Thurs., 9 Nov., 6 p.m.
EDINBURGH
"Brushless Variable-Speed Induction Motors Using Phase-Shift Control," by Professor F. C. Williams and others. South East Scotland Subcentre. Carlton Hotel, North Bridge, Edinburgh. Tues., 7 Nov., 7 p.m.
GLASGOW
"Education: Why Bother?" by Dr. K. R. Sturley. South West Scotland Subcentre. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow C2. Wed., 8 Nov., 6 p.m.
SALISBURY
"The Protection of High-Voltage Insulators from Power-Arc Damage," by Dr. A. E. Guile. Southern Centre. Offices of the Southern Electricity Board, 17 New Canal, Salisbury. Wed., 8 Nov., 6.30 p.m.

Institution of Electronics

PETERBOROUGH
Open Discussion Meeting. Peterborough Branch. Peterborough Technical College, Eastfield Road, Peterborough. Fri., 10 Nov., 7.15 p.m.
SUNDERLAND
Film on Electronic Topics. Sunderland Branch. The Technical College, Sunderland. Fri., 10 Nov., 7 p.m.

Institution of Engineering Designers

NEWCASTLE UPON TYNE
"A National Standard in Engineering Design Education," by W. A. A. Witham. North East Branch. Rutherford College of Technology, Northumberland Road, Newcastle upon Tyne. Mon., 13 Nov., 7.15 p.m.

Institution of Engineers and Shipbuilders in Scotland

GLASGOW
Open Discussion Meeting. Tues., 7 Nov., 6.30 p.m.

Institution of Mechanical Engineers

LONDON
"Port Handling of Cargoes: Are Dockside Cranes Outmoded?" Discussion. Manipulative and Mechanical Handling Machinery Group. Mon., 6 Nov., 6 p.m.
"Refrigeration Lubrication": Discussion. Lubrication and Wear Group. Tues., 7 Nov., 6 p.m.
"Gear-Tooth Contact Phenomena," by Dr. H. E. Merritt. Nominated Lecture. Wed., 8 Nov., 6 p.m.
"Automatic Control." Brains Trust Meeting. Automatic Control Group. Thurs., 9 Nov., 6 p.m.
BOURNEMOUTH
"Development of Extrusion and Forging Machinery": Discussion. Southern Branch. Durley Hall, Durley Chine Road, Bournemouth. Thurs., 9 Nov., 7.30 p.m.
COVENTRY
"A Theory of Brake Squeal," by Dr. R. T. Spurr. Automobile Division. Hotel Leofric, Coventry. Tues., 7 Nov., 7.15 p.m.
LOUGHBOROUGH
"Diesel-Electric Locomotives," by G. V. Davy. East Midlands Branch. College of Further Education, Loughborough. Thurs., 9 Nov., 7.30 p.m.
MANCHESTER
"Consideration of the Lubrication of Free-Piston Gas Generators," by R. M. Hostie and G. M. Barrett, with recent material by D. L. Saunders-Davies and L. E. Lowe. North Western Branch. College of Science and Technology, Manchester. Thurs., 9 Nov., 6.45 p.m.
NEWCASTLE UPON TYNE
"Metallurgy in Relation to Mechanical Engineering," by J. A. Brown. North Eastern Branch. Neville Hall, Westgate Road, Newcastle upon Tyne. Mon., 6 Nov., 6 p.m.
NORTHAMPTON
"Movement in a Ball Bearing"; Chairman's Address, by E. G. Longman. Eastern Branch. Gaumont Restaurant, Northampton. Thurs., 9 Nov., 7.30 p.m.

Institution of Production Engineers

LONDON
"Cold Forging," by F. Griffiths. Royal Aeronautical Society, 4 Hamilton Place, W1. Mon., 6 Nov., 7 p.m.
COLCHESTER
"Packing," by J. E. Evan-Cook. Ipswich and Colchester Section. Canteen, Davey, Paxman and Co., Ltd., Britannia Works, Colchester. Fri., 10 Nov., 7.30 p.m.
PRESTON
"Spark Erosion," by P. J. C. Gough. Preston Section. Harris College, Corporation Street, Preston. Wed., 8 Nov., 7.30 p.m.
WOLVERHAMPTON
"Industrial Research in Britain," by P. Spear. Wolverhampton Section. Wolverhampton and Staffordshire College of Technology, Wolverhampton. Wed., 8 Nov., 7.15 p.m.

Institution of Structural Engineers

LONDON
"Development of Engineer Equipment for the Army," by Brigadier H. A. T. Jarrett-Kerr. Thurs., 9 Nov., 6 p.m.
BRISTOL
"Engineer Support to the Christmas Island Nuclear Tests of 1958," by Brigadier R. B. Muir. Western Counties Branch. Queen's Building, University Walk, Bristol. Thurs., 9 Nov., 6 p.m.
NEWCASTLE UPON TYNE
"What is Structural Engineering?" by P. D. Newton. Northern Counties Branch. King's College, Newcastle upon Tyne. Tues., 7 Nov., 6.30 p.m.
SOUTHAMPTON
Chairman's Address, by J. R. Lowe. Southern Branch. The University, Southampton. Fri., 10 Nov., 6.30 p.m.

Junior Institution of Engineers

LONDON
"Food at Zero," by R. M. Cooper. Fri., 10 Nov., 7 p.m.

Liverpool Engineering Society

LIVERPOOL
"Gas in Industry on Merseyside," by H. C. Elles. Wed., 8 Nov., 6 p.m.

North East Coast Institution of Engineers and Shipbuilders

NEWCASTLE UPON TYNE
"Photoelasticity and Its Application in Marine Engineering Research and Development," by J. West and F. S. Lynam. Neville Hall, Westgate Road, Newcastle upon Tyne. Fri., 10 Nov., 6.15 p.m.

Presentation of Technical Information Group

LONDON
"A Critical Evaluation of Modern Duplicating Techniques," by H. R. Verry. University College, New Engineering Block, Malet Place, WC1. Thurs., 9 Nov., 6.15 p.m.

Radar and Electronics Association

LONDON
"Space Communications." Part II. "Orbits and Their Economics," by Dr. W. F. Hilton. Royal Society of Arts, John Adam Street, WC2. Thurs., 9 Nov., 7 p.m.

Reinforced Concrete Association

LONDON
"Shrinkage and Creep in Concrete," by Dr. A. M. Neville. Royal Society of Arts, John Adam Street, WC2. Wed., 8 Nov., 6 p.m.

Royal Institution of Chartered Surveyors

LONDON
Presidential Address, by E. C. Strathon. Mon., 13 Nov., 5.45 p.m.

Royal Society

LONDON
"Sound Generated Aerodynamically," by M. J. Lighthill. The Bakerian Lecture. Thurs., 9 Nov., 4.30 p.m.

Royal Society of Arts

LONDON
"New Developments in the Use of Solar Energy," by Dr. Harold Heywood. Thurs., 9 Nov., 5.15 p.m.

Sheffield Metallurgical Association

SHEFFIELD
"An Analysis of Refractory Materials," by H. Bennett. Methods of Analysis Group. BISRA Laboratories, Hoyle Street, Sheffield. Tues., 7 Nov., 7 p.m.

Society of Instrument Technology

LONDON
"Semiconductor Diodes and Rectifiers in Control Engineering," by P. R. Wyman; and "The Transistor in Control Engineering," by Dr. G. D. Bergman. Control Section. Manson House, 26 Portland Place, W1. Mon., 6 Nov., 7 p.m.
BIRMINGHAM
"The Mathematics of Process Control," by F. G. Farley. Midland Section. Gosta Green College of Technology, Aston Street, Birmingham. Fri., 10 Nov., 7 p.m.
GRANGEMOUTH
"Development of a Precision Pressure Generator for Multiple Instrument Calibration," by B. E. Adams. Grangemouth Section. Leopark Hotel, Bo'ness Road, Grangemouth. Thurs., 16 Nov., 7 p.m.
LIVERPOOL
"Our Technology and Our Society," by G. C. Eltenton. Liverpool Section. Industrial Centre, Merseyside and North Wales Electricity Board, Paradise Street, Liverpool. Thurs., 9 Nov., 7 p.m.
MANCHESTER
"The Role of the Physicist in Plant Instrumentation," by Dr. L. J. R. Postle. Manchester Section. Literary and Philosophical Society, 36 George Street, Manchester 1. Mon., 13 Nov., 6.45 p.m.

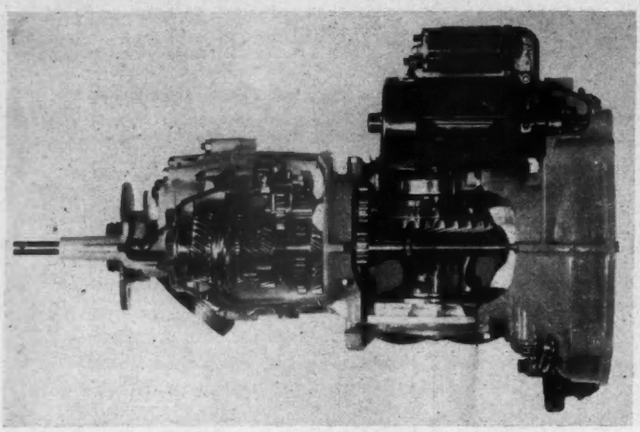
South Wales Institute of Engineers

CARDIFF
"Some Problems of Shaft Inset and Pit Bottom Roadway Construction at Abernant Colliery," by T. Vaughan Thomas. Thurs., 16 Nov., 6 p.m.

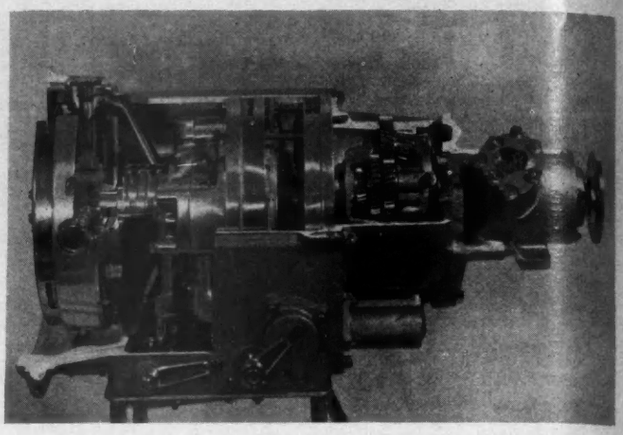
Events in Advance

Association of Supervising Electrical Engineers, 23 Bloomsbury Square, London WC1. (LANgham 5927)
British Association for Commercial and Industrial Education. Apply to Mr. T. H. J. Field, British Road Services, Melbury House, Melbury Terrace, London NW1.
British Institution of Radio Engineers, 9 Bedford Square, London WC1. (MUSeum 1901)
Building Centre, 26 Store Street, London WC1. (MUSeum 5400)
Combustion Engineering Association, 70 Jermyn Street, St. James's, London SW1. (WHItehall 5536)
East Midlands Metallurgical Society. Apply to Mr. H. L. Parker, 4 Aylesbury Avenue, Chaddesden, Derby.
Illuminating Engineering Society, 32 Victoria Street, London SW1. (ABBey 5215)
Institute of Marine Engineers, Memorial Building, 76 Mark Lane, London EC3. (ROYal 8493)
Institute of Metals, 17 Belgrave Square, London SW1. (BELgravia 3291)
Institution of Agricultural Engineers, 6 Queen Square, London WC1. (TERminus 0140)
Institution of Civil Engineers, Great George Street, London SW1. (WHItehall 4577)
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London WC2. (COVent Garden 1871)
Institution of Electronics, 78 Shaw Road, Thornham, Rochdale, Lancs. (Oldham Main 6661)
Institution of Engineering Designers, 38 Portland Place, London, W1. (LANgham 8847)
Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow C2. (Central 5181)
Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London SW1. (WHItehall 7476)
Institution of Production Engineers, 10 Chesterfield Street, London W1. (GROsvenor 5254)
Institution of Structural Engineers, 11 Upper Belgrave Street, London SW1. (SLOane 7128)
Junior Institution of Engineers, Pepys House, 14 Rochester Row, London SW1. (VICtoria 0786)
Liverpool Engineering Society, 9 The Temple, 24 Dale Street, Liverpool 2. (Central 3717)
North East Coast Institution of Engineers and Shipbuilders, Bolbec Hall, Newcastle upon Tyne 1. (Newcastle 20289)
Presentation of Technical Information Group. Apply to Mr. B. C. Brookes, University College London, Gower Street, WC1.
Radar and Electronics Association, 45-47 Mount Street, London W1. (GROsvenor 4477)
Reinforced Concrete Association, 94-98 Petty France, London SW1. (ABBey 4504)
Royal Institution of Chartered Surveyors, 12 Great George Street, London SW1. (WHItehall 5322)
Royal Society, Burlington House, Piccadilly, London W1. (REGent 3335)
Royal Society of Arts, John Adam Street, Adelphi, London WC2. (TRAfalgar 2366)
Sheffield Metallurgical Association, 64 Crescent Road, Sheffield 7. (Sheffield 52865)
Society of Instrument Technology, 20 Queen Anne Street, London W1. (LANgham 4251)
South Wales Institute of Engineers, Park Place, Cardiff. (Cardiff 23296)

XUM



The transmission casing for the four-speed, all-synchromesh gearbox on the VW1500 differs greatly from the original designs and is now split transversely. The starter under the rear seat, is one of the less favourable features.



Hobbs automatic transmission, showing forward clutch unit (main and secondary) attached to the flywheel; the single disc 2nd and 3rd gear brakes and the twin-disc 1st gear brake; and the compound epicyclic gear train.

Automatic Transmissions for All Cars

In the third of his three review articles, Gordon Wilkins this week deals with automatic transmissions, which are now available for all sizes of car.

By Gordon Wilkins

THIS year's Motor Show may mark the beginning of a major movement towards automatic transmissions on 1½ litre cars, the fastest-growing category in European industry. The time is ripe, for increasing urban traffic congestion is making driving very onerous for the commuter and many of them would welcome the chance of dispensing with clutch pedal and gear lever.

So far, adoption of automatic transmissions on the larger cars has been held back by the substantial penalties in weight and cost involved and also by the reluctance of second-hand car buyers to accept cars with automatic transmission, which has meant that they often changed hands for no more than a car with normal transmission. However, decreases in weight and cost, plus greater familiarity, may change this situation.

1,500 cc CARS

Borg-Warner have spent £5 million on building and equipping an extension to their English factory to produce their new light three-speed transmission. With oil included, it weighs only 128 lb or perhaps 16 lb more than a normal flywheel, clutch and gearbox. This is a saving of about 85 lb compared with the larger transmission already used on many British cars. Extensive use of light alloy die castings has helped. There are two sizes of torque converter, 11 in and 9½ in diameter, according to the torque to be handled. Maximum torque conversion ratio is 2 to 1 and there is no lock-up clutch as on the larger transmission. The various gear ratios are obtained by the usual multi-disc clutches and brake bands, and there are two oil pumps, one driven from the output shaft so that the car can be pushed or towed in an emergency.

The selector has five positions: Lock-up, Drive, Neutral, Reverse and Park. In Drive, the transmission starts in first and changes automatically to second and top according to speed and throttle opening. Accelerator kick-down gives downshifts to second. In Lock-up, L, the car starts in first and holds it with no safety shift upwards. By selecting L when in top, and kicking down on the accelerator, the driver can obtain second and the transmission will hold it until he makes another kick-down shift to first or returns to Drive by moving the selector. Top gear remains engaged down to 8 to 10 mph unless the driver uses the kick-down, thus avoiding unnecessary downshifts in traffic driving.

The diagram at the top of the opposite page shows the power flows in the various combinations.

1 In Lock-up, the first gear is obtained by engaging clutch A, connecting converter to rear sun gear and brake D which holds the pinion carrier stationary. The forward sun gear rotates freely.

2 In Drive, the first gear is obtained by connecting the converter to the rear sun gear, but the one-way clutch E now holds the ring gear and the band brake D is free. The vehicle can coast on the overrun with the gears free-wheeling.

3 With either Lock-up or Drive selected, second gear is obtained by connecting the converter to the rear sun gear by clutch A and applying the front band brake C to hold the front sun gear stationary.

4 For top gear, the front clutch A connects the converter to the rear sun gear. Rear clutch B also connects converter to front sun gear, causing the gear set to rotate as a unit.

5 In Neutral and Park, all brakes and clutches are released.

6 In Reverse, the rear clutch B connects the converter to the front sun gear. The gear brake D holds the pinion carrier stationary.

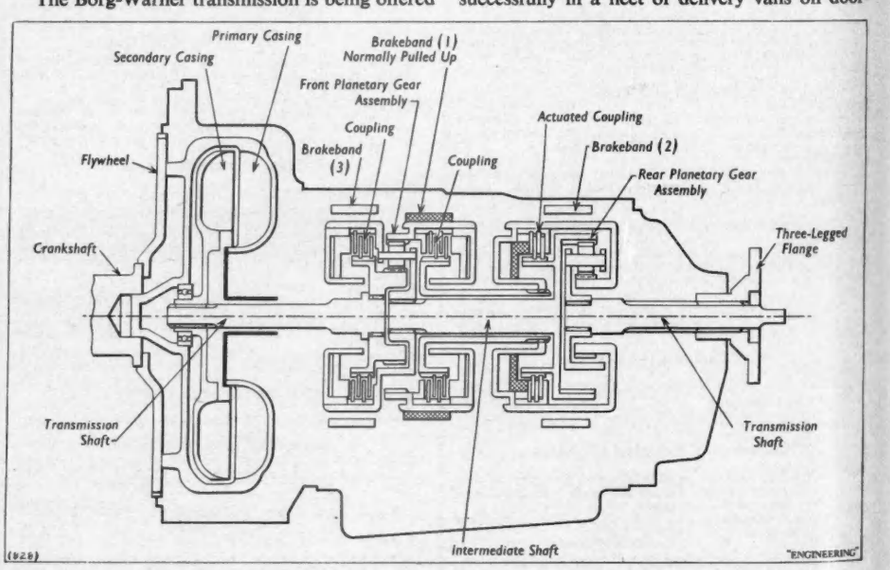
The Borg-Warner transmission is being offered on BMC 1·6 litre cars and other manufacturers are testing it. It adds about £68 to the basic price of the car.

At present the only other automatic transmission available in England on this size of car is the Smiths Selectric three-speed offered on the Rootes Group cars. This is a three-speed unit using normal gears (not a planetary train) and it has an electromagnetic powder clutch, so mechanical efficiency is high. Second gear can be held to provide engine braking. At present it adds about £94 to the basic price of the car and entails a change from four speeds to three, but a four-speed unit is under development.

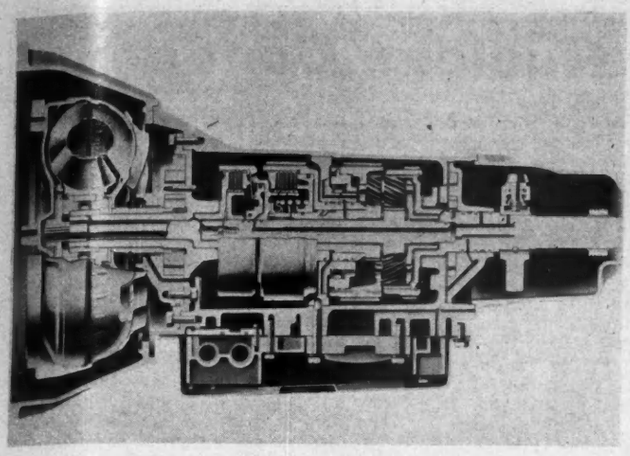
Several manufacturers have been running experimental cars fitted with the Ferguson Teramal transmission for some time, but so far none has decided to order it. Basically this consists of a hydro-kinetic torque converter, with an auxiliary gear interposed between the crankshaft and converter to give a " Plus Gear " for acceleration or hill climbing.

SMALL CARS

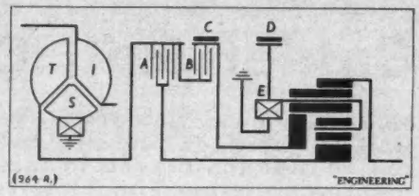
The fourth type of transmission, suitable for small-medium cars, is the Hobbs Mecha-Matic, illustrated above the title. This was sold as the " Hansamatic " on Borgward cars before they went out of production and has performed successfully in a fleet of delivery vans on door-



The new Mercedes-Benz automatic transmission which obtains four speeds and reverse from two epicyclic trains.



The Borg-Warner lightweight three-speed transmission. The selector has five positions: Lock-up, Drive, Neutral, Reverse and Park.



	A	B	C	D	E
Lock up 1	★			★	
Drive 1	★				★
Lock up 2, Drive 2	★		★		
Drive 3	★	★			
Neutral					
Reverse		★		★	
Park					

to-door service, where it showed savings in maintenance costs and fuel consumption.

To demonstrate the efficiency and durability of the transmission, it was fitted in an XK 140 Jaguar which was raced during 1960 and this year it has been used in a Lotus Elite coupé which has put up some remarkable performances in sports and Gran Turismo car events at home and on the Continent. It will probably be made available on a new Beardmore taxi now being developed. Tooling is now being carried out to permit quantity production at the rate of 500 a day. There will be two types: one suitable for engines of 1,000 to 1,500 cc which gives four forward speeds, weighs about 105 lb, and would add about £45 to the basic price of the car according to present estimates, and another for cars up to 2½ litres which weighs about 120 lb. The hydraulic control units are common to both; sizes of gears, clutches and brakes are different.

The Hobbs uses a compound epicyclic gear train with no ring gear, combined with friction clutches, hydraulically loaded. Full manual override is provided through the selector lever, enabling the driver to hold any one of the four forward speeds. In automatic operation upshifts are, as usual, at higher speeds than the down shifts to avoid "hunting," and change speeds are modulated by throttle opening.

The main drive takes up the drive smoothly from a standstill and there is no creep. Indirect ratios are obtained by the application of disc brakes acting on parts of the gearing, and for top gear a secondary clutch is provided to lock the gear train and give direct drive. The main and secondary clutches are housed in a self-contained oil-tight unit which is bolted to the engine flywheel. Oil pressure to operate clutches and brakes is supplied by an engine-driven pump, enclosed in a housing with the pressure and delivery valves. A second oil pump, driven off the output shaft of the gearbox, acts as a governing device, relating gear shifts to road speed.

The manual selector enables any gear to be held on acceleration and a manual down change can be made at any time, by moving the selector, subject to safe engine speeds. Down shifts can also be obtained by accelerator kick-down.

LARGER CARS

Among transmissions for larger cars, General Motors have introduced an American-made three-speed version of the Hydra-Matic for the Vauxhall Velox and Cresta, the German Opel Kapitan and the Australian Holden. It is a very compact unit, adding only about 30 lb to the car weight. The selector allows first or second gear to be held, and both these gears will provide engine braking. Unfortunately this transmission adds £120 to the basic cost of the car before tax.

A general similarity to the layout of the Hydra-Matic is to be found in the new four-speed transmission introduced this year by Mercedes-Benz for the 300SE saloon and certain 220SE models. It consists of a fluid coupling and four-speed planetary train. By a combination of three multi-disc clutches and three brake bands, four speeds and reverse have been obtained from only two simple epicyclic gear sets. The unit is only 3 in longer and weighs only about 30 lb more than a standard clutch and gearbox.

The main components are shown diagrammatically. For first gear, the first and second band brakes are applied, and the two gear sets in series give a ratio of 3·98 to 1.

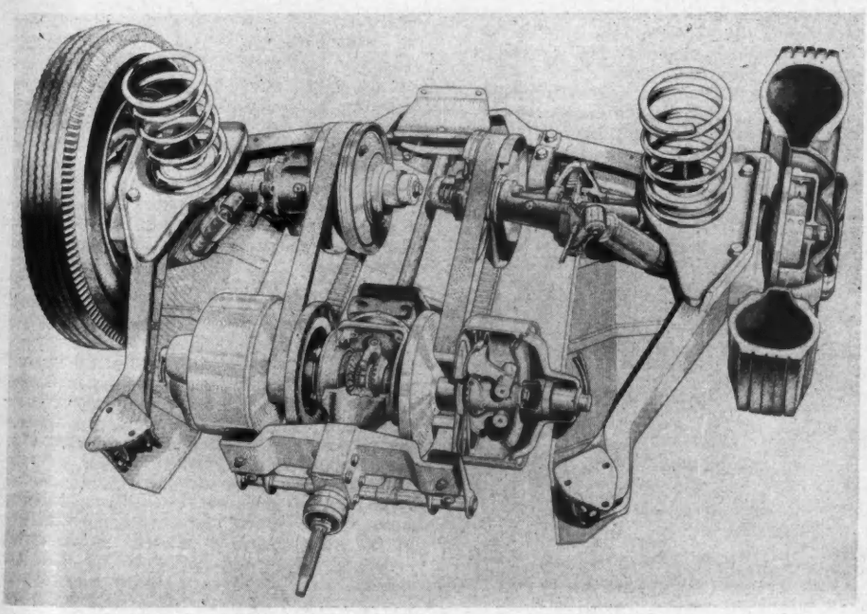
For second gear, the first band brake and the second clutch are applied. Only the first planetary set is in use, giving a ratio of 2·52 to 1.

For third gear, the first clutch and the second band brake are applied, the second planetary is set in use, giving a ratio of 1·58 to 1. For top gear, both clutches are applied to give direct drive. Reverse is obtained by using the third band brake and the clutch, the reversal of rotation occurs in the first planetary set and the second set gives the necessary reduction. A forward clutch will never be loaded with more than single engine torque and the forward bands never transmit more than 1½ times the engine torque.

Upward shifts follow the full power curve of the engine, but down shift occurs at fixed low speeds, unless the accelerator kick-down is used. This avoids unwanted down shifts, producing a sudden increase in torque which could be embarrassing on icy roads.

A feature of this transmission is the unusual smoothness of all gear shifts upwards and downwards. It is obtained by a new servo arrangement on the brake bands, used for the forward speeds. Shift quality is best if the brake band is applied at the exact moment when the sense of drum rotation is about to change. The time interval between start of shift and the change of rotation can vary between zero and 0·8 sec and it is difficult to obtain sufficient speed by the use of metered orifices only. Me cedes-Benz have therefore introduced brake bands which float between two hydraulically loaded pistons, one at each end. The band is brought into a "waiting" position and at the moment the change of rotation takes place, servo action generated by the brake itself effects the appropriate changes in oil flow through a circuit incorporating the two pistons.

The problem of unwanted down shifts has also been given attention by the designers of the Dutch small car, the DAF. Its transmission is by separate belt drives to each rear wheel via pulleys of variable diameter. Change of ratios is effected by varying the distance between the halves of the pulleys under the action of induction depression and centrifugal governors. But the degree of depression is no longer dependent solely on inlet manifold conditions. There is now a vacuum reservoir with non-return valve. A partial increase of throttle opening unaccompanied by any change in road conditions will now give a progressive change upwards, finally producing the effect of top gear acceleration. A down shift will, however, be made instantly if the accelerator kick-down is used. This, with the higher output from the new engine of 75cc, should make this little car much less fussy.



The transmission unit of the small DAF car with a 750 cc engine.

Calder Hall Confirms Nuclear Confidence

Five years' operation of Calder Hall "A" reactor consolidates the confidence placed in this reactor system. The experience indicates the reliability to be expected from the present civil power reactors.

OUTPUT of the Calder Hall station has been raised from 180 MW to 225 MW(t) since its commissioning, an increase of 25 per cent; this has been done by increasing the fuel temperature from 408 to 418° C, based chiefly on new developments with the magnox canning material, and increasing the output of the gas blowers to their full capacity.

By using computers to adjust the absorber pattern, an improved and more even form of neutron flux distribution, and hence temperature distribution, across the core, has been obtained. This is explained by the fact that with unirradiated fuel the horizontal flux distribution across the core follows a cosine law. Since neutron flux is proportional to temperature, the maximum fuel element temperature that may be permitted is therefore governed by the temperature of the fuel in central channel. By placing neutron absorbers in the form of boron and stainless steel rods in the position of maximum flux, the peak in the flux graph may be reduced producing an overall broadening out of the curve across the core. Thus a more even temperature distribution is obtained and the numbers of channels that can work closer to the maximum temperature is greatly increased.

Although the station is basically a plutonium producer, $4{\cdot}7 \times 10^9$ kWh of electricity have been produced and $3{\cdot}7 \times 10^9$ kWh have been sent out to the grid. Compared with the conventional base load stations very high load factors have been possible, and these have been rising each year. In 1959-60, the load factor was 83·2 per cent, and 1960-61, 88 per cent. A limitation of the Calder Hall design has been the need to unload and reload with the reactor off power. At first the loading operation for the 10,176 elements took eleven weeks, but work study applications have reduced this to three weeks; and now the criteria for starting up is the amount of maintenance that has to be done, since this is accumulated until the reactor is shut down.

On reactor No. 4 an overall load factor of 95·6 per cent was achieved last year with the reactor running continuously. Of the remaining 4·4 per cent of time, 2·5 per cent was taken up on experimental work and 0·7 per cent on scheduled maintenance of ancillary equipment. There were no fuel element failures during this period.

The design burn-up for the natural uranium fuel was 1,000 MW days per tonne, but three channels in No. 1 reactor have had the same elements in for four years, with resultant burn-ups of 3,900 MW days per tonne and the average for the reactor is 2,700 MW days per tonne.

There have only been five or six real failures to the fuel elements during the five years and most of these occurred during the first period of operation. There have been about 200 cans with cavitational leaks, and these have usually been found in the cooler end of the core. In positions 1 and 2 at the bottom of the channel, the temperature is in the 140° C range and the low temperature ductility of the magnesium aluminium ("magnox") canning material will be imposing the limitation. Recently a pressure test has been introduced by operating the reactor at 100 lb per sq. in immediately after the reloading operation; the pressure is dropped suddenly and any gas that has entered through the can will leak out, and the accompanying increase in radio-active fission products in the coolant gas will be recorded by the burst cartridge detection equipment. Since this test has been used, there have been no serious failures and the number of cavitational leaks also has been greatly reduced.

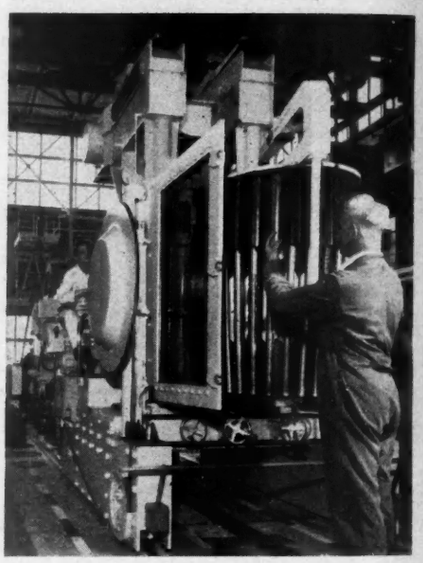
EXPERIMENTS FOR CEGB

Work has just finished on the reblading of four of the eight steam turbines to cater for the increased power output from the reactors. The original design output figure was 21 MW which was subsequently increased to 23 MW without any modification to the turbo-alternators. The recent reblading has improved the output figure to 27 MW (e), giving an overall improvement of 28 per cent. It is estimated that the cost of the reblading will be repaid in twelve months by the sale of the increased electricity produced. It has only been necessary to increase the capacity of four turbines, because the plutonium processing plant at Windscale will shortly be taking the equivalent of half the steam produced by one reactor when operating at full load. This steam will be used for process and space heating. The present conventional steam plant that the Windscale site uses is a relic of the Courtaulds factory that used to be on the site during the war, and has now come to the end of its useful life. A complicated network of piping is being constructed between the Calder Hall and Windscale sites to transport the steam. At Chapel Cross, however, the complete set of turbines have been rebladed and a similar power increase has been made.

It was originally thought that it would be necessary to conduct Wigner energy releases at certain intervals on the Calder Hall reactors, but the need for this now appears small. If it should be necessary nuclear heating will not be used; instead an independent system of electrical heating is available.

An experiment made recently proved, more than any other conducted so far, the stability of the reactor. One of the reactors was run at a half power rating and steady conditions obtained with the control rods out. The carbon dioxide gas circulators were switched off, and the control rods remained out. The temperature rose by 120° C to a maximum in 1½ minutes and then started to fall. The experimental results closely followed theoretical predictions, and in spite of the comparative rapid rise in temperature, no fuel element failures were experienced.

The Central Electricity Generating Board's reactors will have a higher gas temperature at both inlet and outlet, but graphite and magnox bring severe problems at low temperatures, so the extreme conditions serve as a good test bed. Some CEGB magnox elements have been in the reactor for 2½ years and no cavitation has occurred. In recent months a method has been developed to roll the finned cans instead of machining; this is not only more economic but causes less disturbance to the crystal structure of the material.

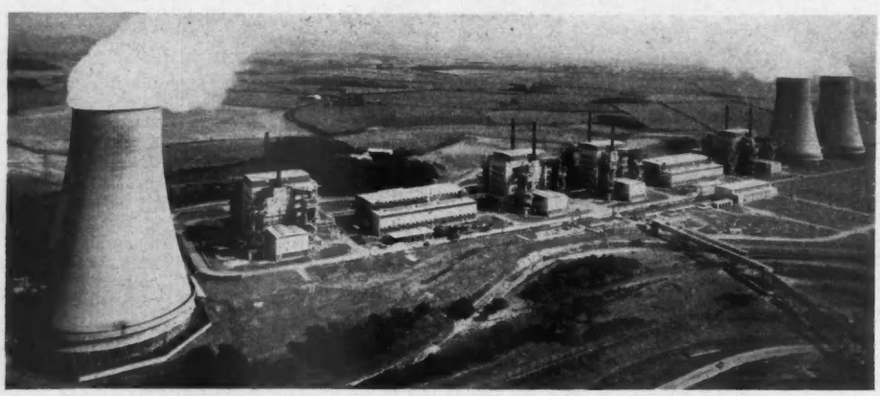


Raising a basket of unirradiated fuel elements into the charge machine before placing them in the core channels.

The problem of fuel elements vibrating in the channels of the civil reactors has been overcome by placing a spring in one of the arms on the spider support that is fitted at the end of the elements.

There is little operating experience available of loading a reactor at full power and of the effects that will be produced. For example, it is uncertain what effect there will be on thermal cycling of the fuel elements in adjacent channels; what will be the effect of the rapid temperature rise on the element being inserted, or what will happen given concentrated use of control rods to maintain the required flux distribution.

To simulate on-power loading, a thermal cycling test was performed by oscillating adjacent control rods up and down for approximately 13,000 cycles and in a later test 30,000 cycles in a temperature range of ± 15° C. The test element was placed in a spare control rod mechanism and adjustment was made to the gas flow, but the experiment did not reveal any unforeseen problems.



Aerial view of the Calder Hall site, with station "A" on the left. Construction began on station "B" in August, 1955, and final commissioning took place in March, 1959.

Human Element

The Danger in a Cup of Tea

TEA breaks, of course, are in the news. Somehow, the public imagination has been titivated by reports of hundreds of factory workers and building operatives downing tools ostensibly because either they can't have a cup of tea in comfort or they can't have one at all.

Now, other firms are proudly telling the story of how they stand outside these troubles by some such world shattering device as giving every man a Thermos flask or introducing tea making machines to the shop floor. One of these tea making machines, indeed, seems to be quite a clever affair which, it is claimed, brews a fresh cup of tea every 12 seconds (when it was timed at 20 seconds per man on shop floor, the extra 8 seconds were, of course, attributed to the clumsiness and chattiness of that now tiresomely overmaligned figure, the British workman).

Undoubtedly, Thermos flasks and tea making machines are good—even important—things in their way, but for heaven's sake let us keep them and the tea break in perspective. If ever there was an occasion for bearing in mind the classic human relations maxim that the immediate reason given for a strike by the strikers is rarely, if ever, the true and complete reason for their action, then this is it. If one really wants to discover the real reason—and not just the last straw—then the first thing to forget all about is the tea break.

Fanfare Return to Academic Life

As announced several months ago, Sir Willis Jackson, F.R.S., who since 1953 has been director of Research and Education with Associated Electrical Industries (Manchester) Limited, has relinquished this post to return to academic life in the position he formerly held as Professor of Electrical Engineering at Imperial College, University of London. Sir Willis's career has been divided between industry and university and has helped to make him one of the major links in this country between electrical engineering and engineering education.

Early in his career, he lectured at Bradford Technical College and at Manchester College of Technology, and carried out research work at Oxford. From 1936 to 1938 he was a research engineer with Metropolitan-Vickers (as AEI (Manchester) then was); in 1938 he was appointed Professor of Electrotechnics at Manchester; in 1946 he began his first period as Professor of Electrical Engineering at Imperial College; and in 1953 he moved back to industry and joined the board of AEI.

Perhaps Sir Willis is best known outside purely electrical engineering for his chairmanship, in 1956, of the Committee on the Supply and Training of Teachers for Technical Colleges, a subject which has become a vital issue in the implementation of the White Paper on Technical Education. He has also been chairman of the Industrial Research Committee of the Federation of British Industries.

Now, his return to university life has been marked by a fanfare of tributes. Last month he received various presentations from his colleagues at AEI and was also elected President of the British Association for Commercial and Industrial Education. This month he has presented his Presidential Address to the Association of Supervising Electrical Engineers on "Some Impressions of Electrical and Educational Developments in East and Central Africa." Sir Willis's impressions were formed on a recent lecture tour in Africa and covered technical aspects of the Owen Falls hydro-electric station and the Kariba Dam project, together with the engineering manpower position and its educational implications in Uganda, Kenya, Tanganyika, Zanzibar and the Central African Federation.

The BPC's Work Study Missionaries

The British Productivity Council's Work Study Unit goes marching on. For six or seven years now it has been stomping the country, putting on one-day and one-week appreciation courses for every type of industrial personnel from managing directors to apprentices. Many a work study engineer and consultant must have been grateful (or ought to have been, anyway) to the BPC staff for the frank and unprejudiced manner in which they have smoothed the way for the application of work study techniques.

Yet, the surprising thing is that there is still plenty of ground for the Work Study Unit to cover in eliminating the same old basic doubts and fears. This was clearly demonstrated at last week's one-day appreciation conference, put on for the benefit of the Central London Productivity Association. Mr. E. A. Carr-Hill and Mr. I. K. J. Phillips, of the Work Study Unit, had to deal with many of the old chestnuts that have been raised since work study began though, of course, they are now asked in the context of present day conditions and some newer problems are also brought up (for example, a year or two ago the unit didn't have to deal with sticky questions like those asked last week about ergonomics).

Last week's conference was chaired by the CLPA chairman, Mr. H. W. Underhill, O.B.E., and organized by Mr. R. G. Cattell, two of the few hundred people who, in local committees and associations throughout the UK, have provided the voluntary help without which the British Productivity Council could not have hoped to succeed in its work. The catholicity of work study was shown once again by the breadth of industry from which the conference delegates were drawn. They came from engineering, printing, office machinery manufacture, paper making, confectionery manufacture, gas supply, chemicals processing and, perhaps most intriguing of all, from a firm of wine shippers and from a goldsmith's.

While the Work Study Unit is still very busy putting on basic and general appreciation courses, however, it has also moved with the more specialized work study thinking and has developed specialist courses in, for instance, organization and methods, hospital work and various types of retailing. As with their work study courses, so with their film programmes, the BPC finds that industry needs new, more specialized films yet still has a big demand for the older, more basic films. That old faithful, "Introducing Work Study," is still very much a best seller or, rather, best hirer.

Specialist Professional Institutions

In this age of increasing specialization, it is desirable that specialist engineers should have the opportunity of meeting and advancing knowledge through professional institutions of their own. At the same time, it is equally desirable that these institutions should work in harmony with the older and more general institutions, both because the older bodies have established administrative machinery and because their broader view can help the specialists to see the relevance of their own work to the wider fields of engineering.

These conditions seem to be met in the projected conversion of the British Nuclear Energy Conference into the British Nuclear Energy Society, due to take place next January.

The British Nuclear Energy Conference was formed back in 1955 by the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Electrical Engineers, the Institute of Physics and the Institution of Chemical Engineers, who were joined later by the Iron and Steel Institute, the Institute of Metals, the Institute of Fuel and the Joint Panel on Nuclear Marine Propulsion. Thus, the Conference was very much the child of the engineering establishment.

Like the Conference, the projected Society will publish a quarterly journal which, in addition to reprinting a wide range of important papers, will contain original papers and discussions, information and authoritative scientific and technological comment from all over the world, and reports on the proceedings of Society meetings.

Membership of the new Society will be open on application to members of the constituent societies of the Nuclear Energy Conference.

Gas Board's New Training Centre

The South Eastern Gas Board have now concentrated the training work formerly carried out in a small central establishment and six divisional centres in an impressive new Area Training Centre in Old Kent Road, London SE15. It was officially opened this month by Sir Dennis Proctor, K.C.B., Permanent Secretary to the Ministry of Power.

In addition to some cutting of costs, concentrating the Board's training facilities in this way is expected to give the following advantages: better administration and control; easier maintenance of the pattern and standard of instruction; greater flexibility in extending and developing internal training; and the broadening effect on trainees of bringing people together from all over the area to exchange views and ideas. Not only will the Board's own training programmes be carried out at the new centre, but this internal training will be integrated here with the administration and organization of all the training and education of Board employees in technical and commercial colleges and similar external institutions.

The administration of this outside training will be an important part of the centre's function, for it is the Board's policy to use Local Education Authority facilities as far as possible. Indeed, some 1,000 to 1,100 employees are enrolled each year for outside courses, including 70 per cent of all employees under 21.

Training at the centre will be largely of a specialized kind not available elsewhere. The scope of this training will include short induction courses for new apprentices and junior staff; technical and sales courses for trainee showroom staff and district representatives; advanced craft courses for senior apprentice gas fitters; regular refresher courses to explain new appliances, techniques, tools and materials; standard codes of practice for mains and service laying; and TWI courses for foremen and supervisors. During each year, 4,000 people will attend courses at the centre with an average of 100 under instruction at any one time.

Company Sponsored University Scholarships

More and more university scholarships are being awarded by engineering firms. This term, Bristol Siddeley financed four students from different parts of the country who have gone up to universities of their choice. The awards were made on the basis of GCE "A" level results and personal interviews, and they cover tuition fees, maintenance and personal allowances.

The scholarship winners are reading mechanical engineering at Cambridge, natural sciences at Oxford, aeronautical engineering at Bristol, and metallurgy at Birmingham. They will spend the major part of their vacations training with Bristol Siddeley at the company's Bristol or Coventry factories. When they graduate, they will return for a two-year post-graduate course with the aero or power divisions of the company.

Another industry sponsored scholar who has taken up residence this term is Mr. Andrew Warren, the winner of the Hunting Group Scholarship at Cambridge. A geography honours graduate of Aberdeen, he has worked in Greenland and in Pakistan and is using his scholarship to carry out post-graduate research into applications of aerial photography.

Friends Worth Winning, People Worth Influencing

In their quest for more labour to meet their expanding production programme, Black and Decker are offering a total cash payment of up to £25 to any employee who introduces a new employee to the company. Employees who introduce a successful applicant for one of the company's published vacancies are paid £5 when the applicant starts work. Up to four further payments of £5 each are made at the completion of each three monthly period in the new employees' first year of work.

There are rumours that some of the more enterprising Black and Decker employees are opening up private labour exchanges.

XUM

Equatorial Equations of Construction

Development in tropical countries has often meant a transplantation of methods used in temporate zones. The problems which arise include those of human as well as material endurance.

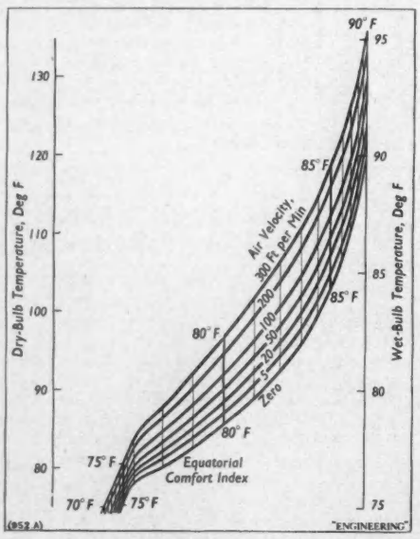
THAT there should be problems at all in consideration of working and building in zones of tropical extremity of the world at once sharply silhouettes the reasons as twofold. Firstly, it had become traditional in the last two centuries for industrial development to be confined to the temperate areas—areas which were the foci of industrial civilizations. Secondly, it was no accident that a temperate climate favoured the more ready emergence and sustained growth of technology: it was in fact a near-optimum environment for human physical effort and for the endurance of materials of construction. The easiest place to work favoured the greatest initial concentration of endeavour and the greatest initial concentration of resources: these in the light of the new technologies and commercial needs of recent times. For otherwise the proportionately gigantic building feats of the ancients (often in the hot countries) would qualify, though these were frequently undertaken for quite different, and commercially speaking, useless ends.

Tropical Difficulties

Therefore, from the temperate standpoint of comfortable development, activities in other climes present strange challenges. As the so-called under-developed parts of the world, which were frequently in the tropic zones, had attention focused on them or began themselves to sense the need for catching up with the rest of the world, so the special requirements of the hot countries grew in significance. Appreciable work and building there had been in these areas across the ages, it is true; but when there began the transplantation of ideas from cooler continents—from Europe and America—there began also the migration of men and the attempted migration of methods and materials. And it was with all three—men, methods and materials—that difficulties arose with an increase in prevailing temperature and humidity and inimical changes in biological environment.

Another salient factor appeared from these new movements: that men both native and foreign to a hot country were for the first time to concentrate together in terrain whose potential dangers and specific difficulties were an unknown quantity. A reference here to the malarial sickness and consequent toll of death which befell the excavation of the Suez Canal will underline this point.

Such was the indigenous unknown of the pioneers; today working hazards have fortunately receded as compared with the building problem *per se*, which is now the prime consideration. It should be remembered that from efforts made to develop the arid countries sprang a new and characteristic industrial civilization in those countries. The conquest of tropical disease, typified by mosquito-borne malaria, the discovery of new methods, materials and designs is for a great part, and increasingly, not their heritage from outside but a gift to civilization as a whole.



Nomogram for the Equatorial Comfort Index. A straight line from the dry-bulb to the wet-bulb temperature gives the ECI by intersection with the air movement curves.

Origins of Developments

Following this concept, that their special requirements are generated at root by tropical countries themselves, from their own resources and not by acquiring design ideas solely from, say, European sources, it is of particular relevance to recall points made by the architectural correspondent of *The Times* (23 Sept. '60) respecting recent examples of building by the Government of Ghana at Accra. Here an idiom has been achieved "that evokes a response outside the tropics, that happens, for its own functional reasons, to echo ideas with which the larger architectural world is experimenting at that moment, either in its perpetual search for new modes of expression or as a reflection of its bondage to the wheel of fashion." *The Times* correspondent sees in the new buildings at Accra "a quite uncanny resemblance to the experiments in simple geometry, with smooth white walls into which oddly shaped window openings have been punched, that constitute one of the most agreeable contributions the younger generation of English architects has made to the problems of escaping from the banalities of the ubiquitous, fully-glazed curtain-wall."

Heat and Humans

A mention of the human problems which arise in tropical areas is justified early in these considerations, as design, for instance of living accommodation, can be governed by physiological requirements as well as by the requisite properties of materials to be used.

Mr. C. G. Webb, a Senior Scientific Officer of the DSIR Building Research Station, has put the overall situation in equatorial countries as often one of *thermal discomfort* which "is mostly a matter of people being too warm; but naturally clothing is rather light in weight, and people easily feel cold too; so that, at least among fully acclimatized residents, discomfort due to cold is more common than one might suppose. Thermal discomfort is not only unpleasant, it reduces the quantity and quality of one's work and therefore one's income, and therefore perhaps one's health and happiness. Continual unavoidable thermal discomfort is really quite a serious matter; and faulty ventilation in a warm, humid climate very easily gives rise to thermal discomfort." (A "comfort graph" for life in the tropics.) The reasoning in this article led to a new scale, the Equatorial Comfort Index, giving information for the air conditioning engineer in the tropics not only to keep people cool, but as to how cool to keep them, drawing data also from Medical Research Council findings. This is the type of guiding principle which has been brought to light by the eventual necessity of housing many more people in one building in tropical areas than had hitherto been the case; and the advent and application of air conditioning systems to control both heat and humidity has been a leading feature of tropical building development.

The concentration of persons in tropical areas has been dealt with by Mr. P. H. M. Stevens of the DSIR Building Research Station in a study entitled "Densities in Housing Areas." This set out what was described as a tool which enabled much better decisions to be made concerning the number of people and the area of land they occupy—the housing area density.

Industrial Plant

Mr. László Takáts, describing his experiences from the vantage of Hungarian foreign trading companies carrying out industrial building in tropical conditions (*Hungarian Heavy Industries*, Winter 1961) brings out the basic differences with home practice by saying: "When constructing industrial buildings in the tropical zone, there are many factors forcing the resolutions to decline from the European habits and having the most significant influence on the shaping of the buildings. The most remarkable are: high air temperature; increased insulation; tropical precipitation; the relative humidity of air; tornado danger; increased risk of corrosion; destructive animals and vegetables and earthquake danger." Mr. Takáts later instances a cogent example of how climate-influenced terrain can predetermine the construction of a power plant: "Local building habits may have a great influence on the plants or on the execution of the construction. In South-Eastern Asia, in territories ruled by the monsoon even at present, at certain geological times there were such precipitate circumstances that in the granulometric composition of the river gravel certain grades of grain could not have been developed and are entirely missing. Therefore when producing a proper quality of concrete, this missing grain grade of the river gravel has to be substituted with crushed and screened stone." The illustration shows a section on the base of the El-Tabin power plant made with floated piles in a discovery ditch. Mr. Takáts goes on to describe how in the delta-zone of the big rivers, such as the congested mouth of the Ganges or the Red River, the level of the subterranean water reaches such a height that it is almost impossible to make cellars for the buildings. Therefore the hot water boiler plants have had to be placed above the highest level of the buildings.

Floated reinforced concrete piles in the basement of the El-Tabin power plant.

Essential Housing

As a contrast in climatic problems associated with population requirements and local economics, in an article headed "Building in the Tropics" (*Architectural Science Review*, November 1958) Mr. D. S. Littlemore described a basic form of housing structure evolved in the re-building

programme in the Papua-New Guinea and Darwin areas. This was made up of a light timber frame and was originally covered on the outside with Sisalkraft paper fixed to the frame with light battens and tacks. Bituminous felt material was also used for a better finish. Little joinery was used and doors and windows were rare. Welded mesh fabric was found to be an ideal material to infill between the timber frames and for insertion in the open spaces, as doors and windows, to hold the "paper" and to give protection from entry. Mosquito-proof gauze was an essential application.

Discussing an element of primary importance in tropical building—the direct heat of the sun—Mr. G. A. Atkinson in "Principles of Tropical Design" (*The Architectural Review*, July 1960) gives some relevant constructional precepts in the Commonwealth context. "Except in the early morning or the cool season, direct sunlight

The Solar Cooker—an experimental device at the Tropical Products Institute, London, evolved during research into the utilization of solar energy for domestic and industrial purposes.

through windows and doors is to be avoided, especially if they are glazed or the building air-conditioned. Shades should be outside the glass. North and south facing openings can be shaded with horizontal canopies which also permit windows to be kept open when it is raining. West and east facing openings, on the other hand, require vertical shades which, if fixed, screen the view and cut down the daylight. For this reason, especially, west-facing openings should be avoided."

In the same issue of *The Architectural Review*, Mr. Richard Hughes showed that in post-war building in Dar-es-Salaam, as in Mombasa, the direct rays of the sun had been countered with concrete louvres or egg-crate brise soleil—more sophisticated screening or air conditioning, which would make for better designs, being precluded by the economic position of the country. The result of concentrating on simple screening in this way, coupled with the low level of craftsmanship available, had been a certain heaviness and crudeness.

It can thus be seen how financial and labour possibilities limit the efficiency as well as the aesthetic aspects of housing in such areas, and that the special requirements for which tropical building calls must mean that larger sums be spent if an optimum of durability and living conditions is to be achieved.

New Under the Sun

The search for new materials of construction for general use in the tropics has gone hand in hand with efforts to make traditional and locally-available materials more long-lasting and resistant to corrosion of one sort or another and to biological attack. A telling example of this approach is in the case of the deterioration suffered by rubber—in the form of tyres, conveyor belts and industrial piping—where too much ozone in the air in areas where green vegetation is sparse (as in South Africa) causes the material to crack. To meet this problem, Monsanto Chemicals Limited have developed anti-ozonant chemicals under the trade name Santoflex. Again, the provision of protective coatings, amounting virtually to a new material as far as resistance is concerned, has represented a vast and diverse field for research. Typifying such work was the report of the British Iron and Steel Research Association in June 1959 dealing with the protection of port and harbour installations against corrosion in the tropics. The specimens exhibited at the time, steel test panels, had been exposed on a beach in Nigeria in permanent salt spray and showed successful protection after 8½ years by virtue of a sprayed coating of zinc or aluminium 3 mils thick.

The Ministry of Supply had formerly carried out exhaustive tests on the behaviour of plastic materials in the tropics, for instance on nylon monofilaments (1957 Report) and cast acrylic sheet (1959 Report). Such materials had yielded encouraging results. The Ministry of Aviation following in 1960 with a report on polystyrene mouldings exposed for two years at five sites in Nigeria had found that "changes in appearance were most marked on the specimens exposed to strong sunlight; these generally darkened. No insect attack was observed on either the exposed or the buried specimens. Metal inserts had no visible effect on the polystyrene. The greatest fall in impact strength and the greatest deterioration in electrical properties were found in specimens exposed to sunlight. Impact resistant materials showed greater deterioration in electrical properties than the others at all sites. Dimensional changes indicated a slight overall shrinkage. The changes observed in softening points followed no obvious pattern." Another Ministry of Aviation Report in 1960, on pvc-covered electric cable, showed that the insulation remained in good condition after two years in Nigeria.

As new and relatively untried materials plastics have offered themselves, on account of their unusually resistant properties, as being potentially likely to succeed in tropically humid climates. It seems that some are in fact particularly suitable, as with the pvc tested as reported above.

Material Economies

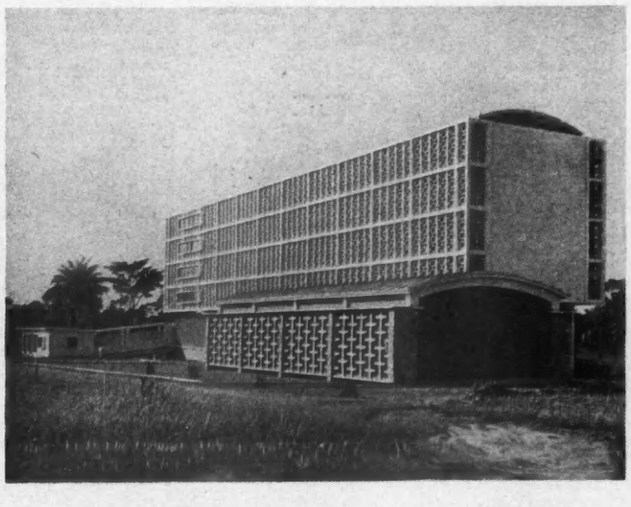
The quest for new ways of exploiting the natural resources of tropical countries in the British Commonwealth is proceeding with vigour by the Tropical Products Institute of DSIR. Recent research here has been following the possibilities of producing particle board—made by bonding together small flakes of vegetable material with a resin bonder under the influence of heat and pressure—to provide a relatively cheap material for the manufacture of furniture and the building of houses in tropical countries. This type of product would present a useful outlet for much waste material and for timber. Under current investigation are knotty thinnings from plantation softwoods, various hardwoods, shells from groundnuts and other tropical wastes. At this early stage, the TPI have already been able to produce a sound particle board from many of these materials. Encouraging results have also been obtained at TPI with the manufacture of building blocks and plaster boards from such tropical waste materials as rice hulls and coir waste mixed with cement or plaster.

Another example of this kind is the development of renewable resources, and much study is now being devoted, for instance, to the structure of coir, the fibre derived from coconut husk. This is now used in matting, mattress filling, ropes and brushes, but it is felt that a vast quantity of husks could be exploited.

Electricity and Sunlight

The problems arising from the necessary tropicalization of such equipment as electrical installations have perforce received much attention. Last year the British Electrical and Allied Manufacturers' Association (Incorporated) reported that the preparation of a draft British Standard for Climatic and Environmental Conditions and Tests for Electrical Power Equipment was in hand. A report published in 1958 by the British Electrical Research Association contained summaries of the reports given at the First Working Session of the International Symposium on Electricity in the Tropics held in Paris in May, 1956. Of these, the report of the German Committee by Dr. M. Böcker summed up the choice of equipment as requiring that "all steel parts should be coated with zinc (if possible, hot galvanized) to make them incorrodible. The protective coat of paint used in central Europe will deteriorate in tropical climates. Porcelain for insulators has proved satisfactory, being resistant to erosive influences and to fluctuations of temperature. When the insulation of electrical machines is in contact with the ambient air, it must not be hygroscopic, and glass fibre materials, sheets of synthetic material and asbestos products are preferable to paper or cotton. All these materials need to be impregnated to exclude moisture. It is advisable to coat at least the electrical connections with silver or tin and to use copper-plated steel for the earth connection."

Finally it is perhaps appropriate to touch on the harnessing of natural energy resources peculiar to the tropics—and the most obvious of these is sunlight itself. Work on these lines is proceeding at the Tropical Products Institute, where the power sources section hopes by modifying existing ideas to devise economic methods of utilizing solar energy for a variety of domestic and other purposes in the tropics.



A building characterized by the perforated concrete sun-screening covering its north and south façades, permitting natural cross-ventilation: the Library at University College, Ibadan (architects: Fry, Drew and Partners).

Faster, More Refined Metal Finishing

Barrelling or tumbling has been used for several years for mechanical finishing. Now, the vibration technique is being used as a faster and better method of deburring, radiussing, descaling, surface blending and polishing.

THE TECHNIQUE of barrelling or tumbling components has itself been developed into a highly specialized type of metal finishing, though this fact might sometimes seem to be belied by the massively crude and Victorian looking contraptions that still lurk in odd corners of numerous small factories and workshops. Now, Roto-Finish Limited, one of the firms who have translated barrelling into terms of modern engineering and precision, have developed the technique of vibration finishing to give yet faster and more accurate deburring, radiussing, descaling, surface blending and polishing.

Vibration finishing is not expected to replace barrelling for all types of components in all types of circumstances, but it does represent a major step forward in extending the already wide range of treatments and types of parts that can be finish processed mechanically. Basically, vibration machines consist of a rubber lined open steel tub freely mounted on four coil springs with, attached to the base of the tub, a vibrator motor operating at 1,500 revolutions per minute.

ADVANTAGES

The rotary action of the motor induces a gentle circulation of the components, abrasive media and alkaline compound contained in the tub and, at the same time, the vibrating action imparts a random agitation throughout the entire depth of the mass to give constant cutting or polishing. A variable amplitude of $\frac{1}{32}$ in to $\frac{1}{4}$ in is obtained by the setting of out-of-balance weights on each end of the motor shaft.

In their quest for an effective vibration machine, Roto-Finish experimented with a method of inducing vibration by means of an eccentric shaft. However, this idea was discarded in favour of the motor because of the possibility of mechanical failures from weld stress and shaft fracture.

One advantage of the vibratory over the barrelling principle is the sheer speed of processing. With some components, the actual machine time can be as much as five or six times faster when using a vibrator, because the component is being worked on for the whole time that it is in the tub, whereas in a barrel the component is only being processed during the actual cascade. The down-time is also considerably reduced by the fact that the vibratory machine is fitted with a compound recirculation system. This can halve the turn-round time by obviating the separate operation of draining off the compound which must precede the unloading of a barrelling machine. Using a compound recirculation system, incidentally, gives the vibrating machine a further advantage in that the same liquid compound can be in constant use for several days' production.

Greater accuracy of finishing is also possible with the vibrating machine since the physical movement of the component is greatly reduced, the cutting media being agitated around the component rather than the component being tumbled through the mass. This makes for uniformity of radii and surface blending without impingement. Another advantage in using the vibrating principle is that the process can be controlled more accurately. A simple adjustment of the out-of-balance weights on the vibrator motor can vary the operation from fine finishing to coarse grinding.

During vibration, too, the abrasive media can penetrate crevices, recesses and the inside faces of cup and tube shaped components in a way that is impossible in the barrelling process. The action of the vibrator can be so fine that delicate or thin-sectioned components—sometimes as small as 0·008 in thick—can be finished without damage or distortion. Examples of such delicate components are 0·017 in steel laminations and needle bolts which are deburred and polished for use in textile machinery.

These particular steel laminations are placed in cylindrical fixtures inside the tub and, in fact, because the vibrating machine is open and the tub remains in the same plane throughout the operation, it is a much easier business to fit fixtures in the vibrating machine than in a barrelling machine. The use of fixtures is invaluable not only for the very small parts but also for bigger components, such as crankshafts, which must not be allowed to collide with each other. Threads and similar precision parts are protected on some other components by masking them off with tape.

A further advantage in using vibrating machines is that the open tub permits easy and quick inspection. This factor, too, makes for closer control over the process.

The Osromatic range of vibratory machines is manufactured by Roto-Finish in capacities ranging from 1 cu. ft to 10 cu. ft. Fig. 1 shows a 7 cu. ft machine being unloaded. In most sizes, the machine has a single tub constructed of $\frac{1}{4}$ in mild steel plate and stiffened with external gussets, the inner and outer seams being welded to ensure adequate strength and the tub lining being $\frac{3}{8}$ in thick abrasion-resistant rubber. The tub, with the vibrating unit mounted externally on its base, is supported on four helical coil springs attached to a sub-frame, the complete assembly of sub-frame, tub and motor being supported on twin stub shafts mounted in two heavy duty bearings.

To make for quick emptying, the tub and its sub-frames can be pivoted about the shafts through 120°—to finish up in the position shown in Fig. 1—using an air-operated tilting mechanism. Components and media are then separated by screening or, in the case of some ferrous parts, by magnetic separation.

TOWARDS LINE PRODUCTION

In addition to the main range of vibratory machines, there is a 10 cu. ft end-unloading model f om which the components and media can be gravity fed to an unloading chute and thence to a hoist pan positioned to suit the rest of the production process. This ability to fit in with an overall production process has been taken a stage further in the automatic vibrafinishing machine—shown in Fig. 2 without its cladding—which Roto-Finish have developed and are marketing to customer order.

This automatic (or, more accurately, semi-automatic) machine has an adjustable cycle time of up to 4 hours and consists, in essence, of a work hopper, a vibrator tub, two bucket conveyor belts, a magnetic separator and a compound storage tank with pumps. The components are loaded into the work hopper which automatically transfers them to the vibrator tub, already loaded with the processing media. After discharging the parts, the hopper returns to its normal position and signals the motor to start up the process. At the same time, a pump starts to circulate the compound from a storage tank to the tub and thence back to storage.

When the process time has been completed, the vibrator motor and the pump motor both stop, and the vibrator tub tips to discharge both the work and the media into a receiving hopper. During this operation, the two bucket conveyor belts, together with the magnetic separator and a rinse spray pump, are signalled into action. From the receiving hopper, the components and media are taken by the first bucket conveyor to the magnetic separator. This diverts the work to a discharge chute while the second conveyor returns the media to the vibrating tub, now back in its operating position.

This semi-automatic machine is a distinct step forward towards providing a vibratory machine which can be incorporated in line production, but the real breakthrough will come if and when Roto-Finish succeed in developing a continuous feed vibrafinishing machine on which they are now working. They have already taken this project to an advanced stage, their prototype machine consisting of two rectangular work tubs fitted with scroll forms and placed in parallel, and two conveyor belts, one at each end of the tubs, to convey material between the tubs.

The two tubs have separate processing compound circulation systems and can be used for two different processes. For example, the first tub might be used for deburring while the second tub is used for polishing.

In this type of continuous machine, the process time is determined by a combination and balancing of the amplitude of the vibrations, the pitch of the scroll form, and the length of the tub. For the moment, however, the immediate practical problem is to ensure a smooth and regular flow of components.

When the foolproof answer to this problem is found, Roto-Finish will have added to the speed and control of their vibrafinishing techniques the priceless asset of being able to incorporate them in line production.

Roto-Finish Limited, Mark Road, Hemel Hempstead, Hertfordshire.

Fig. 1 Unloading a 7 cu. ft Osromatic Vibrafinish machine. In this case, the compound and media are being separated by screening.

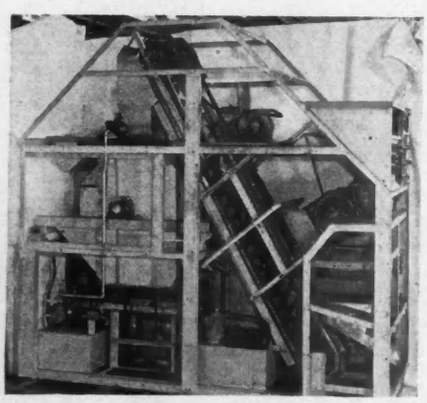


Fig. 2 The automatic vibratory machine with its cladding removed. The work tub is on the left, the magnetic separator on the right.

Fault Warning in Automated Systems

The rapidly spreading use of automation techniques in power plants, oil refineries, chemical plants, factories and workshops places a heavy responsibility upon a much reduced number of operators. These people have the difficult human task of remaining fit and attentive through long periods of comparative inactivity so that they can deal immediately and correctly with any sudden fault in the system. If their reaction to trouble is not immediate and correct, the result will certainly be expensive and often dangerous.

To meet these circumstances, where it is essential that safety devices are actuated and staff warned when a fault occurs in a complicated sequence of operations, Gresham Automation have designed and manufactured a new fault warning system. This equipment is claimed to be reasonably economic in relation to the capital outlay on plant. It is a particularly reliable and safe system because it is designed entirely in the solid state, with transistors and printed circuitry, and, having no relays or moving parts, is protected from mechanical failure.

The system is manufactured in modules so that it can be quickly and comparatively cheaply tailored to service any number of control or measurement points in any type of automated plant. It is designed to actuate audible warnings through loudspeaker amplifiers and buzzers, and also give visual indication of the location of a fault either at the relevant point in the plant or in the control room or both.

Further, the system can indicate when the fault is being attended to and when it has been corrected. It can also be used for indicating and, by suitable connections, recording fleeting faults which occur and self-correct before an operator or supervisor can take action.

One of the many examples of how the system might be arranged to operate is as follows:
(*a*) Plant in complete action: green lights illuminating appropriate wording at each control or measurement point in the plant.
(*b*) Occurrence of a fault: audible warning sounds; green light is extinguished at faulty point and replaced by a flashing red light.
(*c*) Fault acknowledgement: operator or supervisor presses button; loud speaker is silenced; red light stops flashing but remains steady, indicating that the fault is being handled.
(*d*) Fault corrected: red light is extinguished; flashing green light replaces it.
(*e*) Plant in complete, normal action again; button is pressed and steady green light resumes.

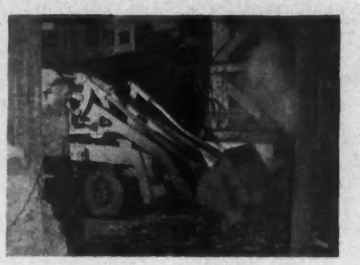
The wide range of fault detection includes such conditions as a breakdown of component, increase or decrease in measured temperature value, pressure or liquid level exceeding a predetermined limit, conveyor system faults, packaging machinery breakdowns, and gas, liquid or semi-solid flow changes. All illuminated points are fitted with twin lamps for added reliability, and the system may be powered through a Gresham power pack or from any low voltage dc source such as a battery.

Gresham Automation Limited, Gresham House, Twickenham Road, Hanworth, Middlesex.

Foundry Mechanized With Its Own Product

The power for three hydraulic loading shovels now being used in the Ford Motor Company's Dagenham foundries is provided by Fordson Major diesel engines. The type of shovel used for this work is the Weatherill-Hydraulic, shown in the illustration, with a 1 cu. yd capacity bucket, an overall length (with bucket lowered) of 16 ft 2 in and an overall width of only 6 ft 6 in. A fourth shovel is used for coke loading.

The primary purpose of the loading shovels is to clear away slag when the cupolas are dropped in the foundry—usually once a day, but more frequently if a 24 hr shift system is being worked.



Loading shovel moving in to pick up slag.

At a given signal, the cupola is dropped, releasing a stream of near-molten slag into the confined space beneath and spilling out over the floor of the foundry a distance of 10 ft to 15 ft. Immediately, cold water is hosed over the slag to lower its temperature slightly, and the loading shovel moves in to pick up the slag (as in the illustration above) and deposit it in a road tipper.

This tipper then deposits its load on a slag heap some distance from the foundry. The loader picks up an average of five or six loads after each cupola is dropped, and the complete operation takes something like 10 minutes.

Before the introduction of the loading shovels, this job was carried out manually, the operators raking the slag clear and shovelling it on to a large skid-plate towed behind a tractor. The plate was then dragged away and the slag dumped into a waiting wagon by an overhead crane. Fords estimate that the use of the shovel loader has reduced time on the job by 50 per cent.

The loaders are standard machines but with power-assisted steering. As the slag is still in a near-molten state when it is being handled, the skip receives far more intensive wear than that for which it was designed and the company have found it necessary to reinforce the bottom of the bucket with 1¼ in steel plate. With these modifications, mechanical handling becomes an economic proposition.

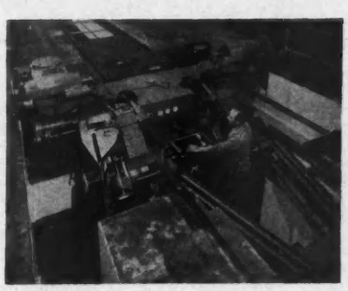
Evidence of their faith in the use of loading shovels for this purpose is the fact that Ford's ordered three more shovel loaders for their foundries at Leamington.

F. E. Weatherill Limited, Tewin Road, Welwyn Garden City, Hertfordshire.

Underfloor Lathe for Easier Maintenance

The third underfloor lathe to be used by London Transport has now been introduced at their Northfields Depot. Like one of the previous two lathes, this model (shown in the illustration) has been designed and constructed by the Scottish Machine Tool Corporation to the transport authority's own specification, but, unlike the earlier machines, which can deal with flanges only, this latest lathe can machine the whole profile of a wheel.

Nowadays, improvements in design and construction in underground rolling stock make it unnecessary for the vehicle body to be lifted from the bogies for maintenance, as was once the case, but there remains the periodical machining of wheels to restore their correct profile. Where it is necesssry for the body to be lifted for this purpose alone, the effect of improvements in other directions is, of course, lost as far as maintenance costs are concerned. The crucial importance of this new lathe, therefore, is that it makes possible the profiling of wheels while they remain in their normal running position.



The underfloor wheel lathe in its operating position, showing the press-button controls, drive rollers and tailstocks. The bridge rails have been swung clear of the working area.

With the earlier designs of underfloor lathes, it was usual for the vehicle wheels to be rotated by drive-rollers mounted on a horizontal axis parallel with that of the vehicle axle, the railway wheels resting on these rollers and the necessary adhesion being supplied by the vehicle's own weight applied through the axleboxes. This dependence on adhesion has entailed limitation of the power which can be transmitted. In the new machine, the drive is applied to the wheels by two pairs of rollers on vertical axes. The rollers are pressed hydraulically against the inner and outer faces of each wheel. The two drive-rollers exert balanced forces on each wheel and no end thrust is applied to the axle.

During machining, the weight on the axle is relieved by hydraulic jacks, which form part of the machine and are applied to the undersides of the axleboxes. Concentricity is assured by mounting the axle between live centres which have power operated movement for raising them into the working position and for lowering them again to positions clear of the rails when the vehicle is to be moved over the machine.

The low-cost tool equipment was specially developed for the purpose and includes carbide "throw-away tip" tools with clamp-type chip breakers. The machine works on the copy lathe principle, with the tool being moved by automatic hydraulic equipment across the wheel and tread, following a master profile. Quick power traverse movement of the tool slides in both directions is provided, with infinitely variable ranges of speeds and feeds. Operations are controlled from a bank of push-buttons.

London Transport, 55 Broadway, London SW1.
Scottish Machine Tool Corporation, Glasgow C3.

High Speed Carbide Bar Turner in USA

Blaw-Knox, of Pittsburgh, have developed and built the first of a new line of Medart high speed centreless bar and tube turning machines specially designed to use carbide and ceramic tooling. The first machine is now in operation in the Baltimore works of the Armco Steel Corporation, where it is handling a wide range of high alloy steels at speeds of up to 30 ft per minute. With smaller bar and tube, feed speeds of twice this rate are said to be possible, and two further companies have placed orders for the unit.

A single cutterhead using mechanically clamped tools makes possible eight cutting edge changes without any resetting of the cutters. All rubbing or friction guides in the cutterhead are eliminated. The patented torque chipper incorporated in all Medart carbide centreless bar turning machines is supplemented by the use of pressure support to give absolute rigidity at the point of turning—a vital point if full advantage is to be taken of the carbide or ceramic tips. Additional rigidity is given to the workpiece through a series of pressure loaded steadying rolls on both the input and output feed devices.

Bars are gravity fed to a selecting device at the input end of the fully automatic machine table and fed into the machine in immediate succession, being kept end to end. The rigidity of the output feed rolls supports the bar as it feeds from the machine, and a high speed mechanism extracts the bar for automatic discharge into waiting cradles or containers.

Separate, variable speed motors drive the feeding elements and the cutting tools to give any required combination of feed and speed.

Blaw-Knox Company, 300 Sixth Avenue, Pittsburgh 22, Pennsylvania, USA.

BRNO INTERNATIONAL TRADE FAIR 1961

Held in Czechoslovakia, 10-24 September

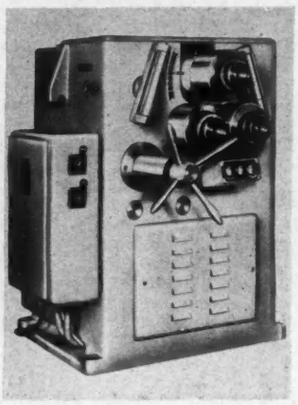
THE Third International Trade Fair, held at Brno during September, illustrated the importance of that country's machine tool and equipment industries, which in fact are the basis of the national economy. The upsurgence which has taken place in recent years in the country's export trade, now places Czechoslovakia seventh in the list of the world's exporters of machinery and plant. The nation is also an important export field for engineering products from Britain.

Countries participating at Brno were separately represented in the Pavilion of Nations; in the other 12 pavilions products were displayed according to their classification. This policy of segregating exhibits of a kind, while not unique, enables comparisons to be more easily made and saves the time of potential buyers. There were over 41 categories which included fittings, pumps, diesel engines, transport, and many types of machinery, electrical equipment, and agricultural equipment. Raw materials and semi-products allied to branches of the engineering industry, as well as consumer goods of an engineering character, were included in the fair.

British firms represented at the fair, either on their own stands or through their agents, totalled 54. The items illustrated and described on the two following pages are representative of the Czechoslovakian exhibits. All of the tools and equipment described are handled by *Strojimport, Václavské Námesti No. 1, Prague, Czechoslovakia.*

BENDING ROLLS

For Cold Working of Sections



INTENDED for cold bending bars of square, flat, angle, T and U-sections, and tubes, the XZP50/7 bending rolls are suitable for ferrous and non-ferrous materials.

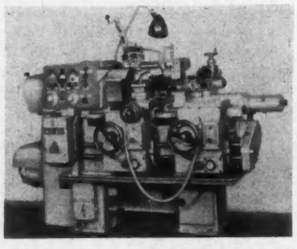
The three rolls are driven by a reversible two-speed motor, the fact that they are all driven is claimed to facilitate operation. When stock is passed between the rollers it is guided by the idling rollers, arranged in the vertical plane, which are free to adjust themselves as required; if necessary, they are easily removable.

To enable smaller-sized sections to be bent into smaller radii than would be possible with standard rolls, supplementary equipment is supplied. This is attached to both the lower shafts and the frame and, as an example, is said to permit an angle section of 20 mm being bent to a diameter of 130 mm (5½ in).

Operations of starting and reverse are push-button controlled. Axial movement of the spider handle alters the gear ratio and rotary movement changes the vertical position of the top roll. The maximum section of angle iron which can be bent is 120 by 120 by 15 mm. The greatest diameter to which material can be curved is 1,250 mm (50 in). Mean diameter of the rolls is 480 mm and the lower roll spacing 550 mm. *Strojimport.*

CAPSTAN LATHE

Programme Controlled



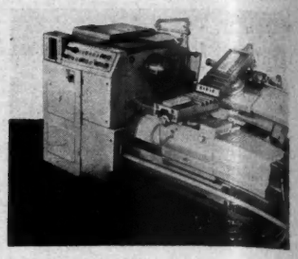
OF MEDIUM size, the RC25 capstan lathe is provided with a turret, programme control, and an electromagnetic clutch.

It is claimed that the design and equipment allow idle time to be reduced. Programme control of speeds and feeds is governed by the indexing movement of the turret and can be set to cover the whole operating cycle. The machine is intended for chuck work up to a diameter of 400 mm and bar work up to 25 mm diameter. A total of eight spindle speeds and eight longitudinal and traverse rates of feed to the front carriage can be set up before starting; when running, the operator, by indexing the turret, automatically operates as many as six individual speed and feed stops, dependent upon the programme set up. For prototype work a change-over switch enables the programme mechanism to be cut out.

With an electrically-operated chuck the machine will take through the spindle bar stock of 25 mm diameter; if the electric chuck is displaced stock up to 35 mm diameter will pass through. The spindle has a bore of 38 mm and a No. 5 Morse taper. Swing over the longitudinal slide is 350 mm and over the cross slide 220 mm. Maximum distance from the spindle nose to the turret is 650 mm. Spindle speeds range from 35 to 100 rpm. Both front and turret carriages have a maximum longitudinal travel of 480 mm. There are 16 longitudinal feeds and the same number of cross feeds. Electrical protection is afforded to the carriages when travelling towards each other and in their extreme positions. *Strojimport.*

SINGLE-SPINDLE LATHE

Semi-Automatic or Automatic



DESIGNED for chuck and bar work, the AB63 single-spindle camless lathe is claimed to be suitable for both short and long runs. Loaded by hand, the machine operates with a semi-automatic cycle. Provided with automatic loading and unloading equipment, the working cycle is fully automatic.

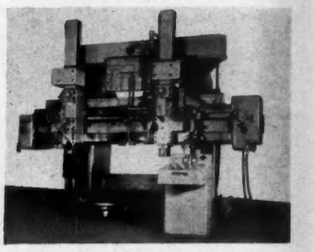
The front and rear cycling carriages can be supplemented with special attachments, with individual hydraulic or electric control. During the work cycle it is possible to change the feed to the carriage and the spindle speed four times or start the carriage travel twice. It is claimed that setting-up time is considerably reduced by the ability to set up toolholders while the machine is running; this procedure is made possible by the provision of a special fixture. This feature and the provision of programme control are said to make the machine one suitable in many cases for work done on capstan lathes.

The greatest diameter which can be swung in the chuck is 500 mm (nearly 20 in) over the lathe bed and 250 mm over the carriage. The maximum permissible diameter of bar stock is 63 mm. The greatest length which can be turned in either chuck or bar work is 400 mm (16 in). Headstock drive is by a 14 kW motor through belts to a countershaft. Spindle speeds are changed by means of dry friction clutches, which are operated hydraulically, and free-wheels. The speed range is from 45 to 2,000 rpm. The maximum torque on the spindle is 120 kgm.

A copy-turning attachment is provided on the rear carriage. Many accessories are available. *Strojimport.*

VERTICAL LATHE

Wide Range of Faceplate Speeds



THE SK25A vertical lathe has two tool heads; the faceplate is carried on a ball thrust bearing.

The machine is claimed to be suitable for batch or prototype production and is said to be equally suited to roughing or precision work. The wide range of faceplate speeds—from 1·18 to 117 per minute—allows optimum cutting speeds to be selected for a large variety of materials and cutting tools over large and small diameters. A cutting speed of 60 m (200 ft) per minute can be obtained when turning a diameter of 164 mm and upwards. The minimum cutting speed when turning a diameter of 2,600 mm is of the order of 9·6 m (30 ft) per minute. The effective torque, measured at all faceplate speeds from 1·8 to 11·8 rpm is reported to be constant at 638.000 kg-cm. Provision of infinitely variable speed enables the most suitable cutting speed to be maintained over the whole width of the machined face.

In addition to the main control panel, there is a portable pendant panel for each head, from which setting the tool into the cut is controlled. Selsyn measuring devices are provided for the horizontal and vertical travels of the heads on the cross rail; the applicable dial scales and indicators are located on the control panel. Accessories available include a copying attachment for use with a template, and a grinding attachment. The latter is suitable for surface, cylindrical, and internal grinding and can be used in either a vertical or horizontal position. Maximum diameter which can be turned by a side head is 2,500 mm (nearly 100 in). The greatest diameter admissible between columns is 2,800 mm (110 in). *Strojimport.*

AUTOMATIC BAR LATHE

Six-Spindle

THE Type AN6/40 six-spindle horizontal automatic bar lathe is intended for the production of components up to 1$\frac{49}{64}$ in diameter and 7½ in in length, in cycles ranging from 8 to 836 seconds, using drawn material with a tolerance of h11 or less, or black reeled material.

Among the lathe's features is the ability to machine simultaneously at two different speeds on a number of spindles. This is claimed to allow optimum cutting conditions for specified processes. According to the work in hand, the machine can operate as a six-spindle one, or as a double three-spindle unit, employing single and double indexing. The latter procedure permits two items of different diameters and length to be machined. The cross carriages are removable, allowing equipment such as that used for hydro-copying to be fitted.

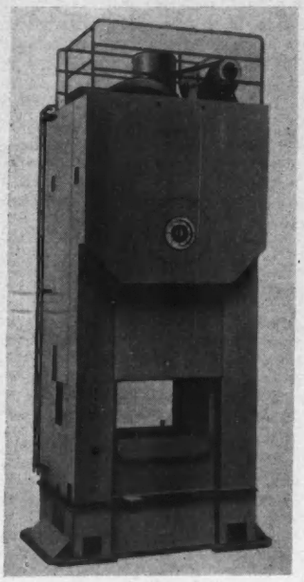
The bed also constitutes the coolant tank. The gearbox gives spindle speeds of from 40 to 2,000 rpm. A crossrail couples the headstock and speed gearbox and houses the main camshafts for transverse and longitudinal feeds. The spindles, similar to those fitted in the Type AN6/40 automatic lathe, are mounted in precision bearings, axial thrust being taken by two prestressed single-row ball bearings with increased radial clearance.

Clamping and feeding material is carried out by hydro-mechanical means. When working material with a tolerance of h11 or less split collets are employed. If rolled material with a tolerance of ± 0·3 mm is used the collet is replaced with clamping sleeves with inlays.

Dimensions of the lathe, excluding the magazine, are 153 in by 55 in by 80 in. The motor is 27 hp. *Strojimport.*

FORGING PRESSES

Transverse Eccentric Shaft



LKM vertical-crank forging presses are available in five sizes, nominal pressures ranging from 630 to 4,000 tons.

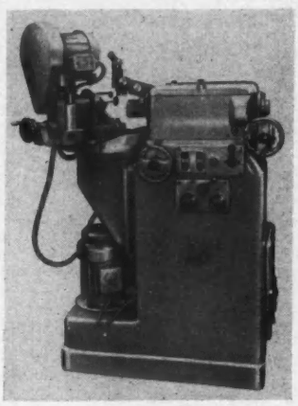
In addition to the claims made for simple control, accuracy, and small craft and machining allowances, it is stated that these presses are noiseless in operation. Power is transmitted to the flywheel which, together with a pneumatically-operated multiple-disc clutch, is mounted on an eccentric shaft which is arranged transversely. It is said that this method of locating the shaft enables the crank mechanism to be kept short with a consequent increase in rigidity.

Both top and bottom ejectors are mechanically-operated and have adjustable strokes. The frame is fabricated by welding, while the bed is a steel casting. Bed adjustment has been replaced by ram adjustment which is said to be easily effected and to leave coaxiality of the die-halves undisturbed.

Widths between uprights vary from 750 mm (30 in) in the case of the smallest press to 1,500 mm (60 in). *Strojimport.*

GRINDING MACHINE

For Pump Plunger Edges



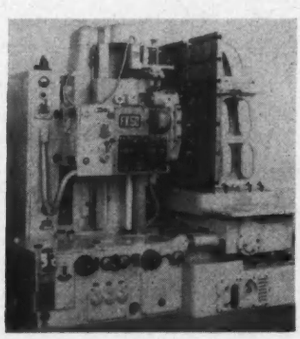
KNOWN as Type BES21, this grinding machine is a special-purpose one produced for grinding the regulating edges of the helical slots of fuel-pump plungers.

The machine is said to be an improvement on those previously produced for this work. Formerly it has been the practice to impart a helical movement to the workpiece by a combination of the rotary motion of the work spindle with the axial motion of the workhead. In the BES21 machine the workhead is practically stationary during the grinding of the regulating helical edge and the principal movement is that of the tailstock sleeve. It is claimed that by eliminating the oscillation of heavy masses greater precision results. A hydraulic mechanism facilitates automatic control of the operating cycle. Adjustment of the workhead setting is made with the aid of an optical checking instrument, fixed on a bracket attached to the workhead, and a reference helix. The speed of all operating movements is infinitely variable over a suitably selected range.

The maximum diameter which can be accommodated is 20 mm. The maximum length is 150 mm, and the greatest lead angle of the ground helix 40°. Maximum length of axial feed of the workhead quill is 22 mm and the maximum angle through which the work spindle can be swivelled 180°. *Strojimport.*

DIE-SINKING MACHINE

With Electric Tracer



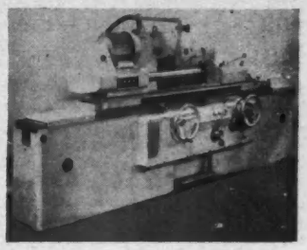
A NEW die-sinking maching, known as Type FK50, has been produced as an addition to the FK08 Type. Like its larger predecessor the FK50 incorporates electric tracer copying.

The copying system now embodied is reported to be an advance on that previously in use. Among other features it is possible to copy from a contour; in this connection impulse for the feed is transmitted directly by the outline of the pattern. This method is reported to cut down machining times, the reduction varying from 8 to 12 per cent, depending on the intricacy of the shape. It is also said that the method of copying offers the possibility of removing material by layers, which may be used to advantage in roughing. Machining times in such circumstances are claimed to be reduced from 20 to 30 per cent. For hollowing-out, the feed range has been extended to include those from 9 to 100 mm per minute. It is possible while machining to engage a feed one-third of that with which machining commenced; this is of value when the material is heterogeneous. A rapid traverse of 1,250 mm may be engaged for movements when the tool is out of cut.

The surface to be machined may have an area up to 0·5 sq. m (5½ sq. ft). The clamping surface of the table is 540 by 960 mm (21 in by 38 in). The table has a longitudinal traverse of 800 mm and a transverse one of 300 mm. Vertical travel of the headstock is 500 to 600 mm. Maximum weight of the workpiece is 2,000 kg. *Strojimport.*

CYLINDRICAL GRINDER

Simple Setting Up



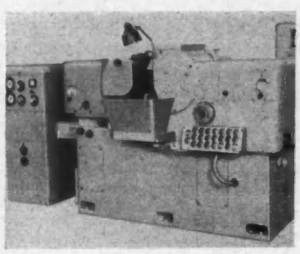
OPERATING with an automatic cycle, the BA25 plain cylindrical grinder is said to be suited to both long runs or one-off work.

Grinding may be carried out either by longitudinal traverse of the wheelhead, or by in-feeding. Functions are controlled by a single lever. Individual operations can be set up by means of the push buttons on the control panel and can be included in three main work cycles. The bed of the machine is in two sections. The compound table is carried on flat and prismatic ways. The top table is able to swivel for tapered work. To enable tapers to be finely adjusted there is a built-in dial gauge which is claimed to eliminate the effect of any possible clearances. The wheelhead cannot be swivelled. The nitrided spindle is mounted on plain bearings which are adjustable.

Normal wheel width is 100 mm when the wheel is of 750 mm diameter; when using wheels of 600 mm diameter surfaces 150 mm in width can be ground. Compound wheels can be positioned to cover a width of 200 mm; individual wheels must not exceed 125 mm. The workhead cannot be swivelled and is adapted for grinding between centres only. Six speeds are provided; these are obtained by using a two-speed motor in conjunction with three-stepped pulleys. Control of the tailstock sleeve is effected hydraulically by means of a pedal, or a hand-operated lever or wheel. In-feed is hand or hydraulically operated. It is reported that this feed is possible by increments of 0·001 mm. The maximum diameter which can be swung is 250 mm. Length between centres ranges from 630 to 2,000 mm. *Strojimport.*

CENTRELESS GRINDER

Semi-Automatic



THE BB6 centreless grinder is arranged for a semi-automatic infeed work cycle. The illustration shows the machine and (left) the tank with hydraulic pumps and electro-hydraulic control elements.

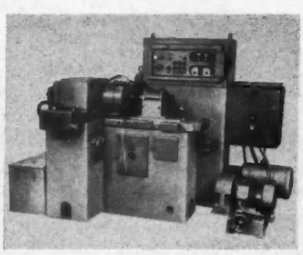
The design is stated to be based on attainment of the highest-possible accuracy. The wheelhead is mounted on three roller ways, which allow infeed by 0·001 mm. The infeed movement occurs when grinding is in progress. The semi-automatic operating cycle of the wheelhead, also controlled electro-hydraulically, consists of rapid approach of the wheel to the workpiece, cutting feed, sparking, and rapid travel to the starting position. The length of the infeed stroke, the extent of the cutting feed and its speed, and the sparking dwell are all infinitely variable. The wheel spindle, running in two adjustable plain bearings, is driven by an individual electric motor.

When grinding by the through-feed method, attention is limited to loading parts in the workrest blade, periodical checking for size, and if necessary correction of size by 0·001 mm by push-button control. When working on runs magazine loading is employed. If incorporated in a link line the magazines can be loaded by conveyors and size may be held with the assistance of an automatic measuring device built into the machine.

With standard equipment the machine will grind diameters from 3 to 63 mm (2½ in). The maximum ground length without feeding equipment is 320 mm (12½ in) and with 195 mm. Greatest diameter of the grinding wheel is 400 mm (15·7 in) and width 200 mm. Normal speed is 1,650 rpm. *Strojimport.*

INTERNAL GRINDER

Independent Drives



BASICALLY the Type BDA25/50 internal grinding machine represents the BDA range, for the machines offered for smaller-diameter holes are generally similar.

The carriages and other moving components are mounted on roller bearings. Independent electric motors are provided for the traversing and for roughing and finishing feeds; infinitely-variable control is provided, speed regulation being obtained by voltage change. Higher cutting speeds are reported to be achieved and increased output is claimed for the machine. The grinding cycle is automated, the only manual operations being loading and unloading. Setting up is carried out by a cycle selector which sets up both individual working phases and dressing phases. Hole size is controlled by the position of the dressing diamond and a measuring device with a two-step plug gauge and optical control equipment.

A hydraulic cylinder imparts sliding motion to the wheel, control is by a copying attachment. The arrangement is said to eliminate impact at reversal. A cam transmits motion to a copying square slide valve, controlling oil supply to either side of the wheel slide. At reversal this cam has zero velocity and the motion is infinitely variable. By varying the cam lift traverse may be varied from 0 to 60 mm. The BDA25/50 machine can, it is reported, economically grind holes with diameters ranging from 25 to 50 mm. The maximum diameter which can be swung is 250 mm. The greatest depth of the ground hole, using the standard spindle extension is 70 mm. The workhead swivels from 0 to 30°. *Strojimport.*

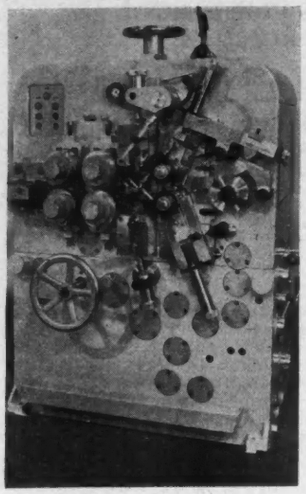
SPRING COILING MACHINES

No Mandrel Used

TAU automatic spring coiling machines dispense with a mandrel and employ one or two coiling forks.

The main advantage of this type of machine is claimed to be the ease with which spring diameter may be changed; this is altered by adjustment of the coiling forks. In view of the infinite variety of diameter permissible within the machine's range, it is styled a universal machine. The method of feed, in which the wire is passed through pulleys which are forced together, is not suitable for soft materials such as copper and aluminium which it is recommended be wound on a mandrel.

Type TAU10 machines process wire from 0·2 mm in diameter, the largest size, the TAU80, accommodates diameters up to 8 mm. The machine illustrated, the TAU50, is intended for winding springs made from material with a diameter of from 2 to 5 mm. It is said to be able to produce springs of the following types: compression, tension and pressure, tension, single and double



conical, concave and convex. The minimum diam of the spring is five times the wire diam. *Strojimport.*

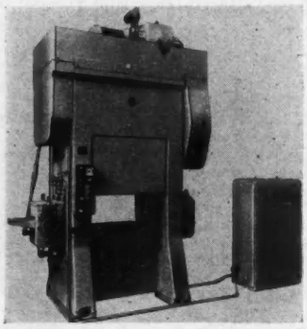
STAMPING PRESS

Wide Range of Operating Speeds

INCLUDED in a range, the TKV100/1000 automatic stamping press shown exerts a nominal pressure of 100 tons.

Main claims made for this machine are its ability to vary strokes from 80 to 220 per minute, and the ease with which it may be maintained. Direct drive of the eccentric shaft is reported to reduce weight and simplify construction. The roll device is said to enable material to be easily fed, while the ability to feed from the front to the back is stated to increase utilization. The press is provided with a pneumatic multiple-disc clutch, built into the flywheel and synchronized with the band brake on the centre of the eccentric shaft. Two pneumatic counterbalances are fitted in the crown.

The machine admits 1,000 mm between uprights, the minimum shut height of 460 mm can be increased by 50 mm by adjustment of the ram. Operation is electro-pneumatic by push buttons; these give continuous working, inching, single strokes, and stop the ram in any



desired position. When the inching control is in use each depression of the push button advances the ram by increments of 0·1 mm. The stroke is 32 mm. Maximum thickness of sheet is 1 mm, width of strip 200 mm. When using coiled stock strips of 2,000 mm are used. With strip stock of limited length the material can be introduced into the feeding device by hand or loaded automatically. The width between uprights is 1,000 mm. *Strojimport.*

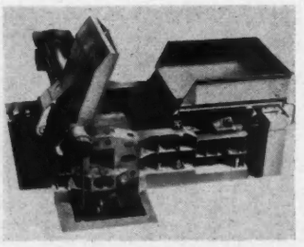
HYDRAULIC BALING PRESS

100,000 Tons a Year

SUITABLE for large scrap yards, the CPA 400-2 hydraulic baling press is offered for the production of bales for open-hearth furnaces.

An extended charging hopper and high-capacity pressing box enable large pieces of scrap to be handled. Capacity is claimed to be 25 bales weighing about 1,000 kg per hour, equivalent to 100,000 tons a year allowing for time out of use for maintenance. Final pressure is obtained with the plunger stationary and the cylinder with the press head in motion. This feature is reported to protect the plunger from possible damage, decrease the floor space required, and add to the rigidity of the equipment.

The pressing box forms the frame of the press and has mounted on it the charging hopper, the first and final presses, and the slide valve. The prestressing equipment is operated by three hydraulic cylinders, exerting a force of 370 tons, which compress the scrap into a width of 600 mm (24 in). The final force imparted to the bale is one of 295



tons, bale sizes are 600 × 600 × 100 to 1,500 mm. The 110 kW motor drives two twin-pressure plunger pumps with working pressures of 125 to 300 atmospheres. The higher pressure is used for the final pressing.

Complete, the press with equipment weighs 115 tons. The length is 10,580 mm and the overall width 8,250 mm. The height, with the charging hopper lifted, is 5,350 mm. The press box, which is lined with grooved armour plating, is 3,000 × 2,600 × 840 mm. During pre-pressing, the comb of the pre-pressing plate meshes with the grooves of the box plates, this is said to result in decreased wear as chips cannot become wedged. *Strojimport.*

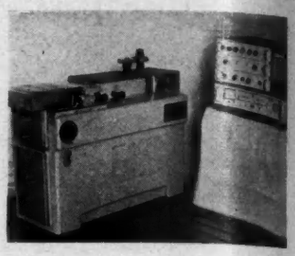
GEAR CHECKING INSTRUMENT

Records Accuracy

NEWLY developed, the IMO32 measuring instrument checks the accuracy of gears and records the results.

The method of measuring employed is said to make possible reading of pitch error within limits of ± 0·5 sec of arc. The instrument allows the checking of the transmission of motion between a reference gear and the gear to be inspected, or directly between two gears in mesh. Where worm gears are concerned, use is made of a reference worm. Such a system may also be employed when checking spur or helical gears. Alternatively the worm gearing to be examined may be checked directly.

The instrument consists of a mechanical and an electronic portion. Located in the mechanical part are the measuring elements proper, tracers, a magnetic gauge, and equipment for the driving and axial adjustment of the gears to be measured. The electronic portion includes the attachments for amplifying, filtering, and tuning the frequency signals and houses the attachment for



recording. Main technical particulars are as follow: minimum axial distance 70 mm; maximum axial distance 320 mm; range of inspected transmissions 4: 1 to 1: 7; range of modules 1 to 6. Maximum diameter of the gear which can be accommodated for inspection is 500 mm (nearly 20 in) and maximum width 110 mm (4½ in). Gears up to 170 kg (380 lb) in weight can be inspected. The equipment for examining pinions admits gears up to a maximum diameter of 400 mm (nearly 16 in) and having a width of not more than 110 mm. The equipment applicable to helical and worm gears covers transmissions with a range from 1:8 to 1:200. Greatest diameter is 350 mm. *Strojimport.*

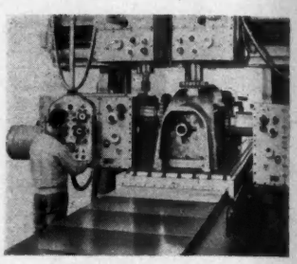
PLANO-MILLING MACHINES

Many Forms

THE FR range of plano-milling machines enables machining to be carried out in several planes at one setting.

Constructed on the unit-head principle, the machines are offered in various types. The four basic designs are: single-housing machines; similar machines with an adjustable arm; double-housing machines; and corresponding machines having a connecting bridge. In all, 13 variants of these machines are available. Table widths vary from 19¾ in to 63 in. Table lengths are from 78¾ in to 236 in. Infinitely variable table and headstock feeds are from $\frac{11}{16}$ in to 39¼ in per minute.

The units have spindles, driven through helical gears, which are fitted with a flywheel and carried on three bearings. Power setting of the spindle to a preselected position, or return of the tool to its original position is said to be possible with a variation not exceeding 0·0008 in. This feature is of value when machining surfaces in one plane which have an intervening obstruction. To avoid



damage to tools and work surface, the tool can be withdrawn, from the surface being machined, on the return stroke. When milling is done by a side milling cutter with a horizontal spindle the tool is automatically withdrawn from the machined surface by a hydraulic-mechanical device which raises the headstock 0·02 in.

Spindle speeds vary from 22 to 1,120 rpm in the VF100 headstock, from 22 to 900 in the VF120 headstock and from 22 to 710 in the case of the VF160 headstock. In each instance 16 speeds are provided. The machines are equipped for programme milling controlled by a punched tape. *Strojimport.*

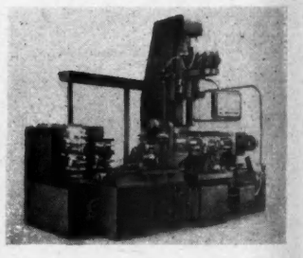
UNIT-HEAD MACHINE TOOLS

Hydraulic Operation

TO meet the need for special-purpose machine tools, unit heads are combined with basic erection and working elements, particularly hydraulic and electronic controls.

The CZM range of components enables the following basic types of unit-head machine to be constructed: (1) tools in which the work remains stationary, (2) tools embodying a rotating circular table, (3) tools with a rotating annular table and a central fixed stand, (4) manufacturing groups. The machine illustrated is the Type T48/I in which the component to be machined remains stationary. It is a combination of standard units supplemented by items, such as clamping devices, tools, and coolant equipment, suited to the particular requirements.

Electrical equipment is housed in a separate sheet-metal case. A panel is provided for each operating unit. A master controller contains signal lamps recording when each moving unit reaches the limits of its travel, any



cessation of feed arising from a defect is also registered. Component movements may be controlled individually or simultaneously. The motor driving the hydraulic pump which controls any particular movement may be cut out if required and the unit returned, during the operating cycle, to the starting position. The electric control panels are arranged so that operating cycles may be changed by altering the programme combination plug and by changing the toolpost relays. If preferred, control panels can be manufactured in series. The machine elements can be reassembled if required or may be incorporated in other machines. *Strojimport.*

Companies

Wellman-Incandescent Group Go Ahead in India

During recent times, there has been a large increase in the amount of business done by the Wellman Smith Owen Engineering Corporation Limited, London SW1, in India, and in these activities, they have acted in cooperation with their associated undertaking, the Incandescent Heat Company Limited, Smethwick, Birmingham.

With the object of extending these interests still further and of facilitating their services to Indian industry, the Wellman-Incandescent group have now opened a branch establishment in Calcutta, which will be under the management of Mr. B. A. Harper.

The activities of the Incandescent Heat group in India have been largely concerned with the supply of heat-treatment furnaces for a wide range of industries, chemical and gas atmosphere plants, and foundry equipment. More than 60 incandescent furnaces have been supplied recently to one Indian steel foundry alone.

On their side, the Wellman Corporation have played an extensive part in the design and construction of Durgapur Steelworks. Among their responsibilities in this connection were the complete open-hearth steelmaking installation, the ingot soaking pits, reheating furnaces for the rolling mill department, coke-oven machinery, cranes and mechanical-handling equipment specially designed for this undertaking.

Participation in the Indian Industries Fair

An indication of the interest being taken by the Wellman-Incandescent group in Indian industry, is their decision to exhibit at the Indian Industries Fair, which is to open in New Delhi on 16 November. Their stand will include a scale model of a complete Wellman-VOEST oxygen steelmaking installation, an illustration of which appears on this page.

In the top left-hand corner of the model will be seen the 7 ton telpher crane, which is used to bring raw materials, such as limestone, iron ore and bauxite, from ground level to the bunkers depicted in the centre of the top floor. These bunkers contain, reading from left to right, burnt lime, iron ore, lump limestone and bauxite. Also on this floor is the cyclone for the powdered lime.

On the floor below can be seen, from left to right, the attritor for pulverizing burnt lime, the iron-ore weigh hopper mounted on load cells, the powdered-lime weigh hopper, the bauxite weigh hopper, and their appropriate conveyors. On the next floor are the feeding additions through the water-cooled stack into the vessel, and the 200 ton ladle crane for charging hot metal into the vessel. The ladle depicted in the model has a capacity of 100 tons.

Shown on the first floor is the 100 ton vessel, together with the drive gear and control pulpits. Below the vessel is to be seen the hot-metal transfer carriage and the ladle. The water-cooled fume stack can be seen passing from above the converter to the by-pass outlet, which is situated at the highest point of the model. The duct to the fume-cleaning plant can be seen leaving the back of the water-cooled stack on the top floor. The oxygen and powdered-lime lance is situated immediately in front of the water-cooled stack.

The Wellman-Incandescent group's display will also include scale models of furnaces that have been designed and constructed by the Incandescent Heat Company and their subsidiary concern, Metalectric Furnaces Limited.

Continued Interest in Marine Engineering

In August last, Mr. O. J. Philipson, chairman of Richardsons, Westgarth and Company Limited, told his shareholders about the changing pattern of demand as between the marine-engineering and land-based power plant industries in which the group have been engaged for so many years. He also referred to certain major changes in the group's organization which are designed to effect improvements in their productivity and administration.

At the same time, the firm are anxious to make it clear that such reorganization does not reflect any alteration in the company's policy towards the marine engineering market. On the contrary, in fact, the firm hope that the administrative changes now being implemented will materially strengthen the ability of the subsidiary companies within the organization (George Clark (Sunderland) Limited, the North Eastern Marine Engineering Company Limited and Parsons Marine Turbine Company Limited) to compete more effectively under the present difficult conditions.

These firms will continue to offer the full range of NEM-Götaverken, Clark-Sulzer and NEM-Doxford engines, as well as PMT and Pametrada turbines. They will also continue to produce Richardsons Westgarth-Foster Wheeler and Richardsons Westgarth-Babcock and Wilcox water-tube boilers, and undertake general repair work.

Successful Year for Lake and Elliot

As was announced early in June, the directors of Lake and Elliot Limited, Braintree, have had under consideration the future structure of their group and the manner in which its scope can best be expanded.

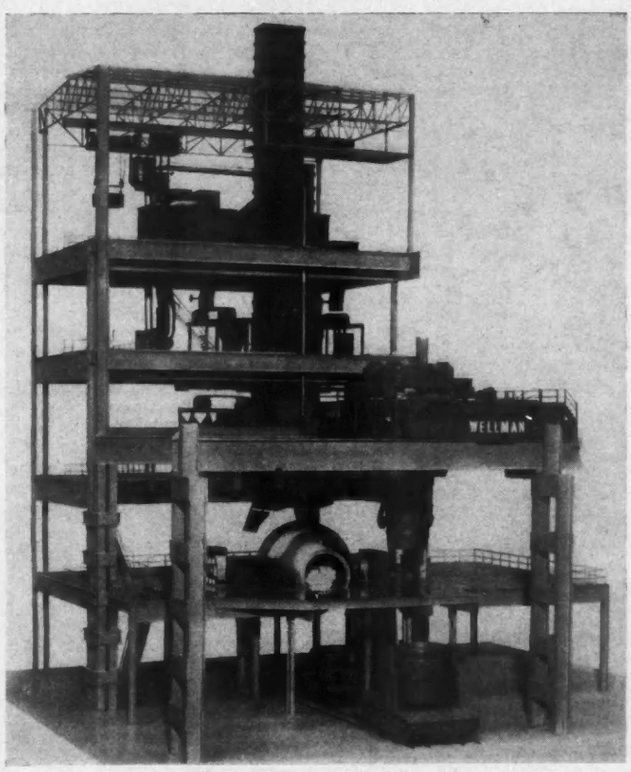
Bearing in mind the differences that exist in the nature of the products manufactured in the foundries and the jack department and the necessity for a greater degree of specialization, not only in the actual manufacturing processes, but also in administration and sales techniques, it has been decided to separate these two activities.

A new company, named Lake and Elliot Founders and Engineers Limited, has been formed to operate the steel and iron foundries, together with the associated machine shops. Another firm, to be known as Lake and Elliot Jacks and Equipment Limited, has been set up to operate the jack and lifting equipment department. Both these firms are wholly-owned subsidiaries of the parent company and commenced trading as from 1 August last.

With a view to enabling the group to trade in markets which have hitherto been very difficult to enter, another wholly-owned operating subsidiary has been formed in France, primarily to produce jacks and equipment within the continent of Europe. This firm will be known as Compagnie Lake and Elliot France.

A site has been obtained near Calais and it is anticipated that production on a limited scale have begun there before the end of July next year. It may be up to five years or more before the French subsidiary is fully developed. Other negotiations for the manufacture of the group's products overseas are in progress.

Mr. C. J. Lake, the company's chairman, affirms that the twelve months ended 31 July last have been a most successful year for the group and that all departments contributed to the much improved result over the previous year.



Wellman Smith Owen Engineering and the Incandescent Heat Company are cooperating in a policy of expansion in India. They are also taking part in the Indian Industries Fair. Among their exhibits will be a scale model of a Wellman-VOEST oxygen steelmaking installation, shown above.

Head Wrightson's Progress in Europe

Although opinions have, of course, been divided, there are many British firms who feel that they could benefit from this country's entry into the Common Market.

Among them are Head Wrightson and Company Limited, Thornaby-on-Tees, a firm who will be celebrating their centenary in the not-far-distant future. In spite of, or more probably because of, the firm's long existence, they are bustling with new ideas and well prepared to meet the challenge of the next decade, as their chairman and managing director, Sir John Wrightson, Bt., has recently pointed out.

Sir John emphasized that Europe was technically a more suitable market to develop, and financially a far easier market in which to operate, than that provided by the comparatively underdeveloped countries of the world. As Head Wrightson's research and development increased in scope and tempo, production would become more specialized and more aligned with the highly industrial requirements of Europe.

This, in turn, would result in more sophisticated engineering products, such as nuclear reactors and nuclear power stations. Delivery times were quicker now because raw materials were easier to obtain.

Further Developments by Laporte Subsidiary

Two large-scale projects are being undertaken by Howards of Ilford Limited, a member-firm of the Laporte Industries Group.

Construction is expected to commence "quite soon" of a unit for producing dicyclohexyl phthalate, a solid plasticizer used in the manufacture of transparent wrapping film and in the paper industry. The new unit will have a much larger capacity than Howard's existing plant and will be able to cope with all likely increases in the home and export requirements of this material for some years to come. Completion is expected shortly.

The other project is the construction of plant for the production of cyclohexanol and cyclohexanone by the direct oxidation of cyclohexane with air. This plant will have an annual capacity of 9,000 tons of total products a year and is expected to be completed by the end of 1963. The cyclohexanol and cyclohexanone products will be sold by Howards either as such or in the form of derivatives.

Experience of English Electric Company

Mechanization of laying-up reinforced plastics is desirable, so that most users would be well-advised, says the author, to make use of the services of a specialist firm.

By C. Hayes,
Reinforced Plastics Division, English Electric Company

USE of reinforced plastics in Britain dates back some fifteen years, to 1946. Most of the early work was done by aircraft companies because of the particular advantages to be gained by the use of these new materials. The English Electric Company was engaged at an early stage in the manufacture of components for the "Canberra" bomber and at a later stage the "Lightning" fighter. Simultaneously, the value of these materials as insulators was considered and development work was carried out at the various factories in the group to take advantage of these properties in company products.

Some two or three years ago the importance of glass reinforced plastics was recognized by the group with the setting up and organization of a central division to deal entirely with this field. At this stage of development, by far the greatest amount of work in Great Britain utilized the so-called "hand lay-up" process, and technical information available to designers was extremely limited.

Aims of Plastics Division

The aims of the English Electric Company's Reinforced Plastics Division, therefore, became threefold:

(1) To supply group designers with a specialized technical design service capable of advising on the correct product design, the most economical production method consistent with requirements, and to provide a production capacity to meet these requirements.

(2) Recognizing the obvious disadvantages of the hand lay-up process, to concentrate on the development of mechanized processes, not only for mass production but for short and medium runs.

(3) To explore the most suitable applications for these new materials and to publicize this information to the group.

When the organization was completed it was found possible to accept business from outside the English Electric group and the Division is now a regular supplier to several other large companies, particularly in the engineering field.

It was soon realized that not only variations in materials but also changes in the processes could produce very variable physical and mechanical properties; the most reproducible results were obtained by some form of mechanized process. Because of this the writer believes that the most obvious course is for organizations requiring glass reinforced plastic fabrications to deal with a specialized company or group capable of handling their problems. However, in order to do this satisfactorily, it is essential that their liaison engineer should have a wide knowledge of reinforced plastics so that some of many pitfalls can be avoided. Two of the more obvious ones can be disposed of here. Firstly the use of these materials does not automatically mean an immediate cost reduction, although this is often possible. Secondly because they are comparatively new they are not necessarily capable of replacing all existing materials at present available.

There are, however, many admirable reasons why glass reinforced plastics should be used at the right time and these should be carefully considered when designing a new product or component. In some of the examples which follow, the particular reasons for producing the component in reinforced plastics are detailed.

Endshields for Mill Motors

These endshields can vary very considerably in size, say, from 3 ft to 16 ft in diameter, see Fig. 1. Previously they were made in wood, cast aluminium or sheet steel. In earlier attempts to replace these materials with reinforced plastics solid laminates were produced to almost the same design as the cast aluminium shield. With further experience gained in this application, the latest shields follow the true design concept for the materials, taking full advantage of their suitability to give sweeping radii and curves. A fault found in earlier models, that of drumming and vibration, has been eliminated by the use of a double-skin honeycomb construction which gives very light structures combined with high rigidity.

These shields are not, necessarily, cheaper than existing types although it is believed that they can be made to compete with the sheet steel models and are perhaps a little cheaper than the aluminum types.

However, there are advantages in the plastics shields which show very considerable savings in use. Because they are light in weight, they can be removed for maintenance purposes by one or two men (depending upon shield size) without the crane that was previously necessary. It can readily be seen, therefore, that maintenance charges can be reduced considerably in service. Additional advantages are to be found in increased safety in service because these materials have good insulation resistance thus allowing the clearances and overall size of the shield to be reduced.

Radomes

One of the earliest applications for these materials was in the protection of electronic equipment. Up to the present time no more suitable material has been found for this application—combining as it does the advantages of light weight and high strength with excellent electrical characteristics thus enabling it to be used as a protective cover with the minimum loss of efficiency of radar equipment, see Figs. 2 and 3.

When utilized for airborne radar the problem is not so much one of finding an economic material as of finding any suitable material at all.

When used as a radome for ground radar installations there are many advantages. They provide a weather shield and eliminate damage to expensive radar antennae while ensuring 24 hour operation even under the most inclement conditions. Further there are savings in the power needed to turn the aerials, and the aerials themselves can be much lighter in construction as there are no wind design conditions to worry about.

Locomotive Components

During the last two or three years a revolution has taken place in certain components required in both all-electric and diesel-electric locomotives, see Fig. 4. This change came firstly in an attempt to reduce locomotive weight but as designs have improved so the use of reinforced plastics has increased as more advantages have become apparent. Doors, because of their one-piece structure and natural resiliency have been found to have a far longer life than was the case with previous materials.

Taking one specific example: a locomotive door was designed which weighed 31 lb against the previous metal alloy weight of 71 lb. In addition, the cost of the plastic door, which on removal from the mould (except for some slight trimming operations), is ready for assembly and final painting on the locomotive, is approximately the same as that of the alloy rough casting which then requires some machining,

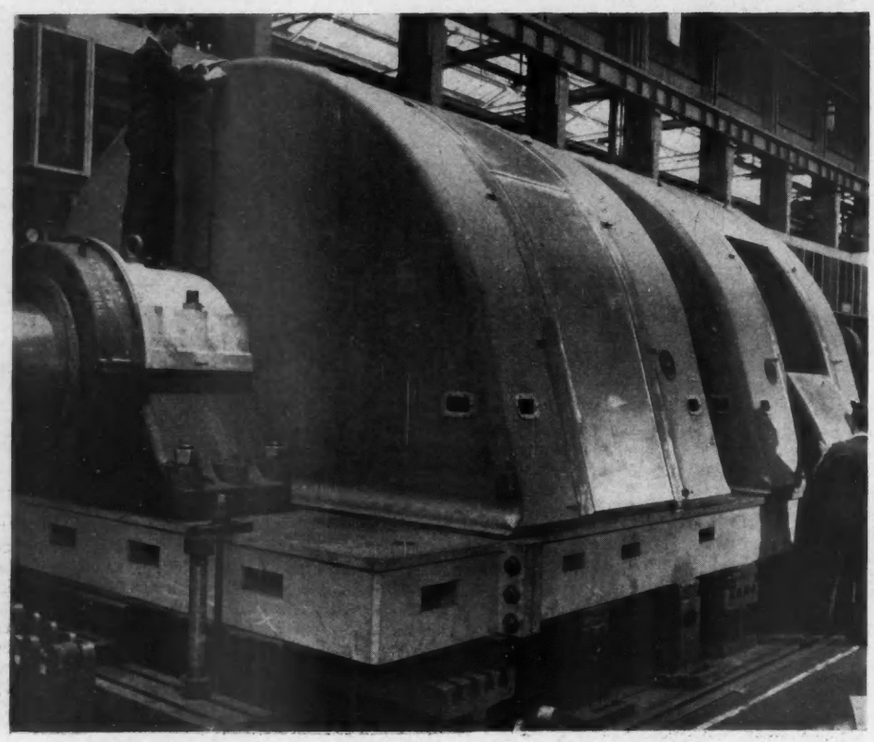


Fig. 1 Glass reinforced plastic endshields being fitted on a 6,000 hp motor destined for a steel rolling mill. The endshields are over 12 ft in diameter.

fettling, forming and painting all at additional cost. At the present time some thirty components are installed in English Electric locomotives, all attesting to the correct usage of these materials. These changes were only effected after a most comprehensive programme had been completed.

In the first part of this article an explanation for the formation of the division was given. Before it could operate efficiently it was necessary to carry out a complete development programme to establish new processes and provide an efficient laboratory which would act not only as a quality control check of incoming raw materials and resin formulations used in production but also carry out a complete evaluation of new resins and reinforcements as they are issued by the raw material manufacturers.

In this connection there are two important facts which need emphasis. Firstly it is our experience that the claims of the raw-material manufacturers tend to err on the optimistic side, and when engineering requirements rather than commercial applications are important it has been necessary to provide our own mechanical and physical properties for the materials based on production experience. Secondly, because both new materials and constant improvements to existing resins, catalysts and reinforcements are continually being announced one must be prepared to evaluate these improvements to keep abreast of the times.

Problems of Staffing

Dealing with the subject of staffing such an organization, the English Electric group was fortunate because the basis of the division already existed in the form of a large department previously engaged on aircraft work. However, it has been found that there is an acute shortage of technical personnel with experience in this industry and it has been necessary for the division to take engineers and train them in reinforced plastics. It is possible of course to obtain people with varying degrees of skill and experience in normal hand lay-up work, but this only emphasizes the extreme shortage of skilled experienced personnel at the present time.

One other problem which has been difficult to overcome has been the establishment of a design and projects office. Having selected suitable personnel it has been necessary to spend a considerable time assembling all the necessary data. The success of this section can be judged from the projects which have been dealt with in the last year, which range from the design of a 120 ft high fume stack to the complete geometry and design of a ground radome more than 100 ft in diameter. It has also been found that the more successful each result is, so the more ambitious future projects become.

It is essential that basic experience is supported by a highly qualified technical and development staff, the aim being to exploit the new processes and new materials which are rapidly bringing reinforced plastics into economic fields which a few years ago would have been impossible. Also, design teams are now able to provide proposals and suggest projects which can show advantages never before possible. It is wise, however, to recall the very bitter lessons learnt in sections of the plastics industry and to be quite certain before each project is approved that the application is correct and that the design is right, so that the result will be a success right from the start.

This does mean that it is very necessary for engineering establishments to consider whether or not the time is ripe now to investigate where or whether their own products will be improved with the assistance of reinforced plastics. The time to start such an investigation is today.

The author would like to acknowledge the English Electric Company Limited for permitting publication of this material.

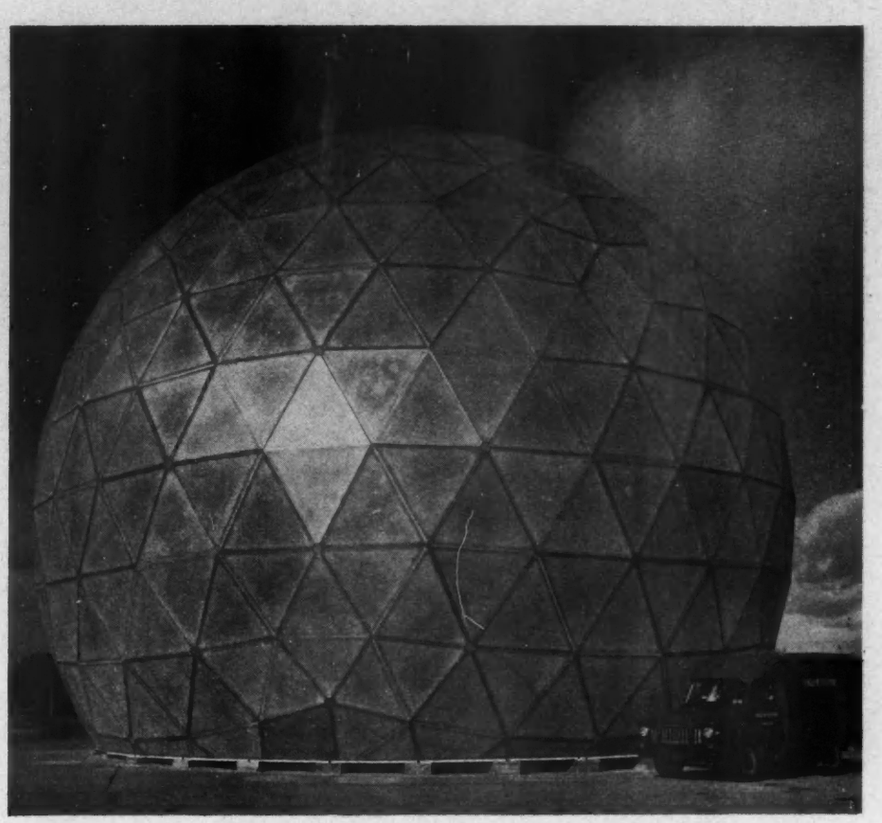


Fig. 2 (above) One of the largest glass reinforced plastic structures ever to be built in Europe. It is a land based radome of about 70 ft diameter which stands over 50 ft high.

Fig. 3 (right) A reinforced plastic radome fitted to the English Electric Lightning fighter now in service with the Royal Air Force.

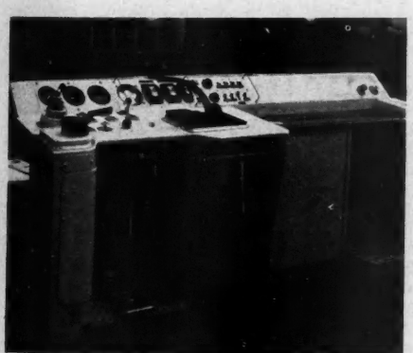


Fig. 4 (left) A reinforced plastic control desk made by English Electric for the AC locomotive supplied by the Vulcan Foundry to British Railways. Below it can be seen several of the 4,000 components made in plastic by English Electric; these are railway traction components.

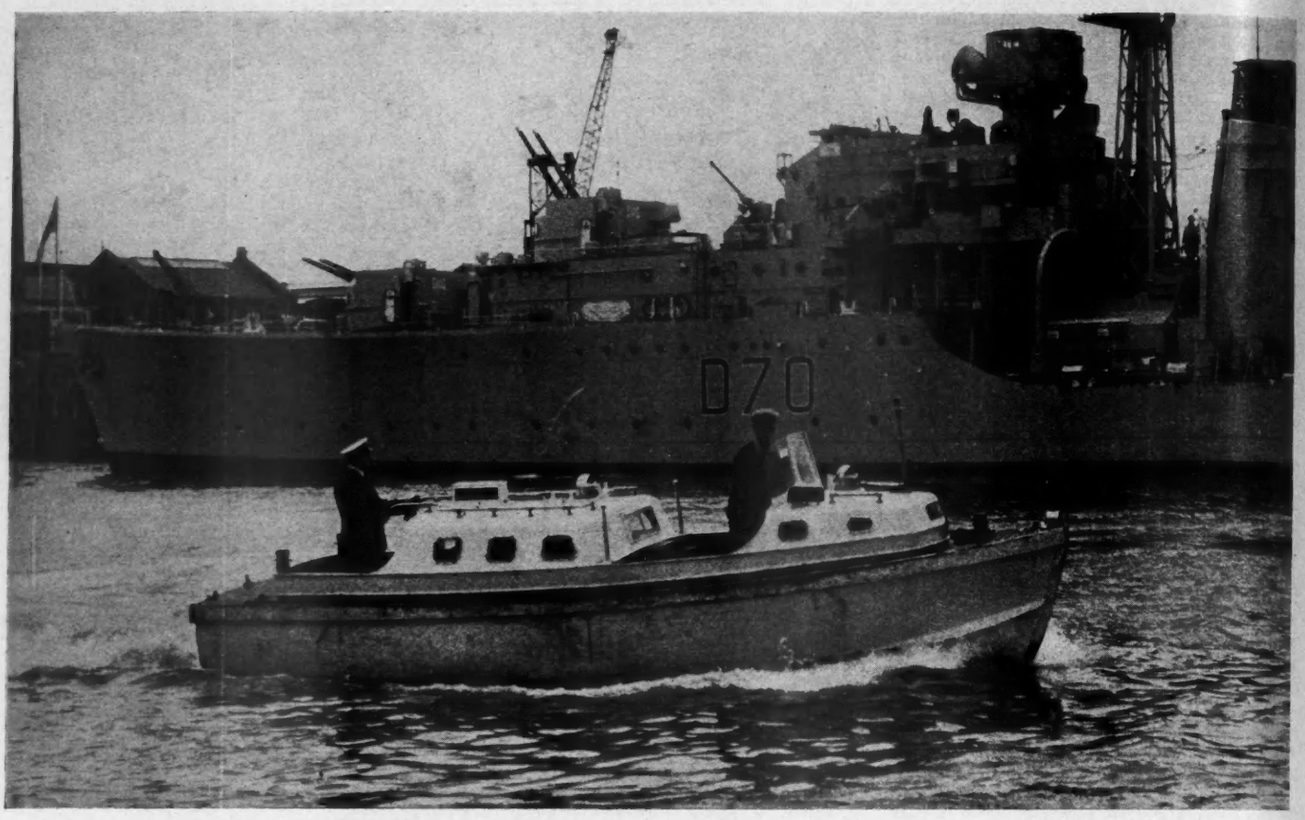


Fig. 1 A 25 ft plastic motor boat at Portsmouth. The Admiralty are now considering plastic for boats over 30 ft long.

Boats: Experience of the Admiralty

The following experiences of the Admiralty with reinforced plastic boats culminate in a series of comments far more reserved than those made by protagonists of the plastic boat industry.

For the past ten years the Royal Navy has been evaluating the use of glass reinforced plastic for boats under 30 ft in length, as a result of which such construction up to this length is now contemplated where numbers will justify the mould cost. The design of larger boats in glass reinforced polyester is under consideration.

Trials carried out with glass reinforced plastic boats during the last ten years have covered craft from 9 to 27 ft in length, operated at speeds of from 6 to 16 knots. Experience has been gained on composite and sandwich construction as well as on round bilge and hard chine designs. Exhaustive testing of boats using both cold-set and hot-set construction has been carried out all over the world in HM ships.

One of the great advantages and financial saving accruing from the use of glass reinforced polyester boats in the Navy is the resultant release of manpower which would otherwise be engaged in HM Dockyards on the removal and maintenance of timber used in traditional wooden boats. A further saving would be made with glass reinforced polyester by abolishing the present need for sheathing of wooden boats used in tropical waters to combat worm and microbe attacks. Apart from the obvious savings of men and money on maintenance, the adoption of the material in small boat construction in the Navy would mean resultant increases in the speed and ease with which boats can be repaired both on board and at shore bases, compared with the wooden boats, where removal of considerable amounts of planking is often necessary.

One of the main disadvantages was the decline in appearance of the glass reinforced polyester boats after considerable use in Fleet service, but recent paint tests carried out by Admiralty research establishments have established that this can be overcome for all except the fast planing boats by traditional brush painting.

Early Dinghy Tests

Admiralty experience of glass reinforced polyester boats began in 1951 when two commercial dinghies were purchased. The first was a 9 ft 3 in boat weighing 96 lb, using resin bonded glass and diagonal mat cold lay-up construction; and the other a 7 ft 7½ in boat weighing 90 lb and using resin bonded glass and swirled mat hot-set construction. These were tested initially over a period of six months by Captain, Coastal Forces, who reported that there had been no difference in their ultimate strength and no repairs had been needed. One dinghy was carried by an RN yacht for the New York to Bermuda Race in 1952.

To gain further experience with cold and hot-set constructions, two 20 ft motor dories were ordered and successfully tested by the Amphibious Warfare Services. One was constructed using the brush-on method over a female mould, the other using the heated pressure bag hot-set method over an aluminium female mould. These, and further trials, showed that although there was nothing to choose from an operational point of view between cold and hot-set construction, in view of the small number of boats required by the Navy the expensive hot-set method was not justified. Further evaluation was therefore concentrated on cold-set techniques.

The next boat acquired by Admiralty, and now on Port Auxiliary Service duties at Portsmouth after seven years use, was a 25 ft medium speed motor boat of cold-set construction using shell and frames of glass reinforced plastic with gunwale, hog, keel and stem of timber, through bolted. The first five months service with the Trials Cruiser HMS Cumberland, in hot weather in the Mediterranean, showed that the hull stood up "moderately well" to Naval handling and withstood impact as well as wooden hulls. The surface tended to crack and craze, especially along the waterline, and was susceptible to damage by abrasion when coming alongside. From the Naval viewpoint a major disadvantage was that appearance of the boat soon deteriorated where a wooden boat would still have been "smart." It was painted in an attempt to improve appearance but paintwork peeled off below the waterline and rubbed off easily. The material continued to abrade easily and the corners of the transom became jagged.

The boat was later issued to the Royal Fleet Auxiliary Fort Rosalie and after two and a half years service it was surveyed (total service 4 to 5 years) with the result: "Better condition than wooden boat of comparable age; abrasions and deep scores of the hull did not show evidence of ingress of water, delamination or leaching out of the resin; through-bolting of wooden members was not a good feature; impact resistance of glass mat reinforcement was satisfactory for Service use; appearance was poor."

From 1959 onwards it was used experimentally for repair and other tests. Large areas of the skin and framing were cut out and repaired by various schemes, bilge keels and spray chines being attached by differing resin/glass systems. Several paint schemes were applied and a new rudder of novel construction was fitted. The boat is still perfectly sound as shown in Fig. 1.

Direct comparisons between composite and all glass reinforced polyester construction were made with four 27 ft motor whalers obtained in

1957-58. Two were of composite construction and two of monocoque construction. One of each type was issued together with a whaler of timber construction to the aircraft carrier HMS Victorious, and the other two were issued to the frigates HMS Puma and HMS Llandaff.

A summary of their trials evaluation is as follows:

HMS Llandaff: the boat was used in all climates, in Icelandic, Home, Mediterranean, Persian Gulf and Far Eastern waters. The hull was superior to a conventional hull. Other than slight surface deterioration, the glass reinforced polyester hull was satisfactory.

HMS Puma: The boat was used extensively and was well tried under adverse conditions. The glass reinforced polyester hull proved superior to a conventional hull, and the boat was satisfactory in every way. Damage received would have been much more severe in a conventional hull, and in one instance resistance proved quite remarkable. The main difficulty experienced was in keeping the boat smart and avoiding patchwork effect of repairs.

HMS Victorious: Only limited use was made of boats available during trials. Monocoque construction using glass reinforced polyester throughout was preferred from cleaning and appearance aspects. Other than slight surface blemish and deterioration glass reinforced polyester proved satisfactory, repairs were quicker and maintenance was easier.

Sandwich Construction: Inherent Buoyancy

Experience has also been gained by the Admiralty with the use of sandwich construction on a 16 ft fast motor boat (Fig. 2). The hull consisted of expanded pvc, $\frac{1}{8}$ in thick, sandwiched between laminations of glass reinforced polyester. This provided inherent buoyancy, a clean internal surface and a degree of rigidity sufficient to allow frames to be dispensed with. The boat was finished in glass reinforced polyester throughout, including canopy, deck and engine case. Service with HMS Cumberland showed some lack of adhesion of the skin laminates to the pvc core (attributed to constructional techniques) but it was considered that the rigidity of the shell and elimination of frames given by the sandwich method of construction was a sound technique for small boats. There was the usual decline in appearance of the boat and although the abrasive resistance of the outer laminate was better than in earlier glass reinforced polyester boats it was still not good enough for Service use.

Following extensive prototype evaluation and modification, the boat was allocated to HMS Tyne for further trials as a result of which it was found that the material showed no sign of surface deterioration; however, the non-skid surface of the glass reinforced polyester deck was not adequate. A reasonable appearance could be maintained by washing with water and detergents.

Other trials or consideration have been, or are still being, given to 52½ ft harbour launches, 9 ft 6 in and 12 ft heavy duty dinghies, 18 ft motor boats and 29 ft survey boats.

As a result of this 10-year trial period the Admiralty has formulated a standard repair kit for plastic repairs, which may also be used for semi-permanent plastic repairs to wooden boats.

Due to the reported "fall off" of appearance of glass reinforced polyester boats, Central Dockyard Laboratory, Portsmouth, are still carrying out tests of numerous paint schemes to ascertain the most suitable for application to the material. As yet, a paint scheme for fast planing hulls cannot be recommended.

Admiralty Conclusions

The conclusions reached by the Admiralty as a result of these exhaustive trials of glass reinforced polyester boats are as follows:

Glass

(1) Low alkali glass is suitable for marine work.
(2) The glass reinforcement must be dry.
(3) Glass mat, although not so strong as glass roving and cloth, is quite satisfactory for boat hulls up to 30 ft in length of low or medium speed with inboard engines.
(4) The introduction of glass woven roving between layers of glass mat should be considered for craft above 30 ft.

Polyester Resins

(1) Selected resins suitable for marine application should be used.
(2) Clear resin for all other than the gel coat of a laminate aids inspection.
(3) A proportion of flexibilizer (or a specially prepared resin) is necessary for gel coat resins to prevent surface crazing, etc.

Fig. 2 The hull of this 16 ft fast motor boat is of sandwich construction about 1 in in total thickness. Between the outer layers of glass reinforced plastic is a layer of expanded pvc.

Epoxide Resin

(1) Should be used for securing items after the hull has cured.
(2) Is most suitable for use as a repair resin.

Fillers

Fillers in the resin mix, in general, increase water absorption properties, and with particular reference to the gel coat, produce a rigidity resulting in star shakes and other surface blemishes. Their use is not therefore recommended.

Construction

(1) Cold set hand lay-up techniques are satisfactory, provided that they are carried out under temperature controlled conditions.
(2) Resin tends to crush around fastenings and it is necessary to place wood, metal pads or special "plastic" washers under the heads and points of through fastenings.
(3) Use of through fastenings should be kept to a minimum because of seepage along the fastenings. It is preferable to bond resin/glass angles or lugs, etc., on inside of glass reinforced polyester hull for securing purposes.
(4) Wooden engine bearers are more economical than glass reinforced polyester for Service boats because alterations are often required when re-engining is undertaken.
(5) Timber and plywood should be used in a glass reinforced polyester hull where it proves to be satisfactory and economic.
(6) Monocoque construction, i.e. side benches, thwarts, flats and bulkheads, etc., all of glass reinforced polyester, should be considered only where very large numbers off are required because of the numerous moulds needed.
(7) Glass reinforced polyester hulls up to at least 16 ft in length can, by use of sandwich construction, be given sufficient rigidity to dispense with longitudinal and transverse framing and buoyant material can be efficiently incorporated.
(8) Glass reinforced polyester decks having a non-slip pattern incorporated in the outer resin layer do not exhibit sufficient non-skid characteristics.

Service Characteristics

(1) Glass reinforced polyester boats, up to at least 30 ft in length, are adequate for Service requirements in respect of strength, impact strength and watertightness.
(2) Not being subject to rot, microbe attack or shrinkage the maintenance of glass reinforced polyester boats is appreciably less than that required for wooden boats.
(3) Tropical service of a glass reinforced polyester boat does not necessitate the fitting of outer bottom sheathing.
(4) Although glass reinforced polyester does not possess anti-fouling properties, marine growth is easily removed.
(5) Repair of glass reinforced polyester boats, both shore-based and shipborne, is simpler and quicker than repair of wooden boats.
(6) "Fall off" of appearance that has been experienced with glass reinforced polyester boats can be overcome, for other than fast planing craft, by painting.

Pipe: Experience of Stewarts and Lloyds

Control is essential to production of good plastic pipe. The author recommends that users should satisfy themselves that makers are carrying out such control so as to avoid disappointment in service.

By E. A. O. Mange
Stewarts and Lloyds Plastics

BY FAR the most important end product of the Stewarts and Lloyds group is pipe for the purpose of carrying liquids. The chief markets are oil, water, gas and sewage of all types, although it must be remembered that these pipes or tubes are also used for engineering purposes such as in chemical plants, mines, lighting columns, ships' derricks, and steel structures.

In its capacity as supplier of pipes to all sections of industry, the company is continually investigating new materials with a view to providing pipe manufactured from the appropriate material according to the usage requirements. For example, for high working pressure or high temperature resistance, and for large bore pipes at even medium working pressures, steel, spun iron or concrete are obvious choices. Even when there is considerable anticipated corrosion a protected steel or spun iron pipe is, in the present circumstances, the most advantageous both technically and economically.

Stewarts and Lloyds have been using some types of plastic for steel pipe protection for very many years, and they commenced examining the possibilities of making pipes from plastic during the early 'thirties, at that time investigating phenol formaldehyde and cellulose acetate. In accordance with their background and tradition of service to their customers, they did not in fact start to market plastic pipes until, after many years of research, they had satisfied themselves that the plastic material from which the pipe would be made would meet the long term requirements for the proposed usage; thus they started marketing in 1957. It has only been since the last war that developments in plastics have made it possible to consider using them on any large scale in the manufacture of pipes, and even now, owing to the low tensile strength of those plastics which are commercially available and have also been tested and proved for long term ageing under conditions of stress, the present economic size limitation on a thermoplastic pipe for medium pressures, i.e., up to about 400 ft head (175 lb per sq. in), is a diameter of approximately 6 in.

Figs. 1, 2 and 3 These illustrations show stages in laying a 4 in bore polyethylene pipe. Note how easily it is handled and floated; also the small coil diameter.

Naturally, there are some special applications where excessive corrosion or chemical attack may make it desirable to make an even larger pipe in plastic, but these are rather expensive. On the other hand, in conditions of corrosion or chemical attack where there is very low or practically no pressure resistance required, such as for fume ducting in chemical installations or effluent wastes, thermoplastic pipes can be used up to 18 in or even 24 in diameter.

At the moment, research and development is continuing to be carried out on the lining and coating of steel pipes with plastics for those purposes where the high tensile strength of steel is necessary, but where the steel must be protected from corrosion or chemical attack.

As a result of work carried out so far, including many very big programmes of laboratory ageing tests, backed up by some years of user experience, it appears reasonable to assume that polyethylene, either low or high density, will be useful in the very considerable market of small bore pipes, mainly for cold water and chemical installations, in diameters from ½ in to 2 in. It must be remembered, however, that in common with other thermoplastics, the tensile strength, and therefore working pressure, decreases rapidly as the temperature rises. For example, although high density polyethylene pipe can be manufactured to withstand a temperature of 100° C at a low working pressure, the material deteriorates fairly quickly at this sort of temperature. In practice it cannot therefore be considered for use with hot water, except in circumstances of nil or almost nil pressure such as waste pipes, or for an installation where only a very short term life is required.

According to present knowledge, either of the two types of polyethylene is suitable for long term use, i.e. over 50 years, for cold water, and it should be noted that there are some oil companies in America using high density polyethylene pipes for medium to low pressure installations in

diameters up to 9 in for the piping of sour crude, natural gases, salt water and potable water.

Moving Cliff Project

Because of its flexibility, polyethylene can often be used economically for special purposes where long lengths without joints are required, or where owing to movement of soil conventional pipes might fail at the joints. A typical example of this was an installation in South Devon, where surplus water had to be conveyed down a cliff which was moving, and where the joints of the previous steel pipe were being broken. In this case four 400 ft lengths of 4 in polyethylene pipe, coiled on a diameter of approximately 11 ft, were taken down to the coast, floated out to sea and towed round to the beach, from where they were dragged up the cliff and connected to the main disposal station, see Figs. 1, 2 and 3. The polyethylene pipe itself was snaked on the way up, to allow for movement of the cliff, and this installation—the whole of which was completed in one day—appears to be working very satisfactorily.

Flood Pipeline in Tunnel

Another occasion where high density polyethylene proved of great assistance was a replacement for a 6 in spun iron pipe in the Glasgow Underground. This pipe was in service pumping away excess water to stop flooding in the tunnel. It was due for replacement owing to corrosion, and there was a maximum of four hours to replace several hundred feet of pipe, this limit being the time in which the water level would have started rising too high. The polyethylene pipe was joined, in sections of 100 feet at a time, with Victualic joints, and carried through the tunnel ready to replace the spun iron; the spun iron pipe was then dismantled and the polyethylene pipe installed within three hours, see Fig. 4. It has been working satisfactorily ever since.

It should be noted that the special considerations applicable to these installations made it possible to pay what would normally have been considered an uneconomical price for the pipe compared with one of the more conventional materials.

The developments of polyvinyl chloride (pvc) during the past two or three years, both as regards production of polymer, compounding and methods of production of the pipe, indicate that this is the most interesting thermoplastic from the point of view of pipe at present commercially available. It is now possible to offer small bore water mains, i.e. 2, 3 and 4 in which, taking into account the lightness and ease of installation, are competitive with spun iron and asbestos cement.

Developments have been carried out in staving the ends of these pipes and forming a Victaulic flange, so that they can be joined by a Victaulic joint which, owing to its rubber connecting ring, enables the pipe to be used as a continuous corrosion-free line which can be rapidly installed. This is of interest for some types of water mains, and in some coal mine and oil company projects. It should be noted that the rubber ring can be provided in any one of a number of synthetic or natural compounds to afford resistance to the liquid being conveyed. With regard to outside corrosion, the joints can be protected either with a coating of plastic and/or the normal types of wrapping tapes already used for protected steel pipelines.

In addition to the above, pvc is starting to be used in large quantities throughout the world for rainwater goods, soil pipes and sewage lines in dimensions up to 12 in diameter, although an economic limit, if there are no other technical considerations, is probably about 8 in at the moment. It is also being used in fume ducting up to 18 and 24 in in diameter, and in these circumstances, providing there are no high temperatures to take into account, it can often effectively compete with stainless steel.

A typical case where pvc shows considerable advantage is that of a projected installation where, owing to rough ground and difficult transport conditions, it is proposed to fly bundles of pvc pipe by helicopter to the site where, because of its lightness, it is quite easy to lay and joint.

Regarding other types of plastics for piping, there are a number of materials coming along which show some promise, and in some cases which can already be used for special installations, usually experimental. However, these materials generally need some years of development and research work before Stewarts and Lloyds would be prepared to recommend them for normal use.

It is worth considering thermosetting pipe, made from glass reinforced plastic in particular. During the last five or ten years there has been a tremendous quantity of development and research carried out with a view to making liquid-carrying pipes of either glass reinforced polyester or epoxy resin. Generally, from the point of view of liquids at pressure, these have been a failure owing to a number of circumstances; for example, too great a variation in the glass rovings themselves; the difficulty of wetting the glass fibres properly with the resin; and the tendency of the pipe on receiving a shock to develop minute cracks between the resin and the glass fibres, allowing weeping at high pressure. One or two companies appear to have overcome these difficulties, but at the cost of making very expensive pipe which at the moment is only suitable for special applications. However, it is worth keeping an eye on these developments with a view to the future.

Glass reinforced plastics can probably offer some very interesting structural possibilities, for lighting columns, corrosion resisting tanks, and roof lights; but at the moment according to the degree of structural strength required, the price is too high except for special applications.

If the use of plastic pipe is to develop satisfactorily in the UK, it is essential for the manufacturers to understand the requirements of the industries they desire to supply. There is an unfortunate tendency in some cases to think that all that is necessary is to buy an extrusion machine and some polymer and start extruding pipe. This is by no means the case. Plastics generally are very sensitive to conditions of manufacture, particularly regarding temperature, pressure, linear speed through dies and conditions of compounding. Any slight variation may cause changes sufficiently serious to bring about a deterioration in the physical properties of the pipe manufactured. Thus, although the pipe may appear perfectly satisfactory on the surface, and even pass some short term tests quite easily, there is a danger that owing to poor conditions of manufacture a certain amount of the pipe at present being supplied to industry will not last for its calculated life of fifty years or more.

Testing and Quality Control

It is necessary that any manufacturer of plastic pipe shall adequately install his laboratories and production lines with a complete system of testing and quality control, and that tests should be carried out repetitively at frequent intervals during manufacture to ensure the highest possible standards.

In order to be able to understand and use intelligently the various types of control necessary, it is essential to have qualified engineers and electricians on the shop floor constantly supervising conditions of production. Although this apparently may increase the cost of manufacture, the advantages from the point of view of a consistent quality and more efficient production outweigh the increased labour charge and increased capital costs. If this approach is neglected by manufacturers there is grave danger that during the next five to ten years there will be a number of failures of installed plastic pipe which will get the whole industry a bad name.

For their own protection, engineers requiring to use plastic pipes should satisfy themselves that the firms from which they propose to buy are adequately carrying out all the necessary production and quality controls. Manufacturers of repute are always prepared to invite engineers who are prospective users to their works, and explain to them and demonstrate their procedure in this respect.

Fig. 4 Polyethylene pipe of 6 in bore was used to replace a similar spun iron pipe in the Glasgow Underground. This shows one of the aluminium Victualic joints and a section with a 2 in T branch.

Plastic Pipe in Perspective

To sum up. It is impossible for the manufacturer of pipes to say: "this is the best type of material to be used for all applications". Each of a number of materials will prove to have its own particular place in industry, including steel, spun iron, concrete, asbestos cement, copper, aluminium and various plastics.

It appears that, of the plastics, the most important one tonnage-wise during the next five years will probably be pvc. In Japan, the consumption of pvc pipe has grown from nil to about 70,000 tons per year since 1954, compared with our own present usage of probably about 2,000 tons per year. There were special considerations in Japan, but even so it would be possible to envisage 20,000 tons per year of pvc being converted into pipe within the next five years in the UK.

Finally, it might be worth putting this tonnage into perspective by noting that at the present time the production of steel and spun iron pipe in this country is in the region of two million tons per year. Steel capacity continues to expand and every year sees its scope and applications increase.

Some Recent Applications and Innovations

Examples on the next two pages illustrate some of the new uses which are constantly being thought up for plastics.

AT THE risk of appearing trite it seems worth commenting that the plastics industry is still in its infancy. If plastics are ever to approach metals in terms of quantity production and use then there will certainly spring up a stockist network around the country similar to the ferrous and non-ferrous metal warehouses. The fact that the number of these can be counted almost literally on one hand indicates that the greater number of engineering companies have not yet taken plastics to heart in the sense that they will ring up the warehouse round the corner and have half a dozen sheets delivered right away.

Exceptions are to be found in individual plastics. For example, large numbers of builders merchants now stock decorative plastic laminates. foamed plastic sheets for insulation, polyethylene tubing, and polyethylene and pvc film. Also the handyman has been offered kits of reinforced plastic through cycle and handicraft shops. But this seems to ignore the potential market for thermoplastic and reinforced plastic sheeting which could exist if engineers knew where to buy them, knew how to fabricate and handle them, and had confidence in their performance. That time is yet to come.

Resin Bonded Paper Rollers

A substantial export order for resin bonded rollers, similar to those shown here, is reported to have been received by the insulation department of Ferranti Limited. The order is from Wiener Maschinen Fabrik of Bayreuth, one of the largest manufacturers of paper conditioning machinery in West Germany.

These tubes were originally designed for use in the transformer industry, mainly for insulation purposes, say Ferranti. However, new and improved grades of resin bonded tubes have recently been developed for mechanical applications such such as rollers in paper conditioning machines, replacing "spar drums" made of copper, aluminium and teak.

Because of their high strength-to-weight ratio and resistance to moisture, mild acids and alkalies, resin bonded tubes—half the weight of equivalent aluminium tubes, according to Ferranti—have found numerous applications in the textile, printing, and paper and pulp industries. As shown here, they can be manhandled, thereby simplifying removal or replacement during maintenance. Again, because of their light weight, smaller rated motors can be employed for driving the rollers, say the makers. In this instance, each tube is 10 ft long and 1 ft in diameter, fitted with cast aluminium end caps and mild steel shafts.

Ferranti paper tubes and cylinders are made from kraft papers impregnated with synthetic resin of the phenol formaldehyde tube and wound under pressure and heat.

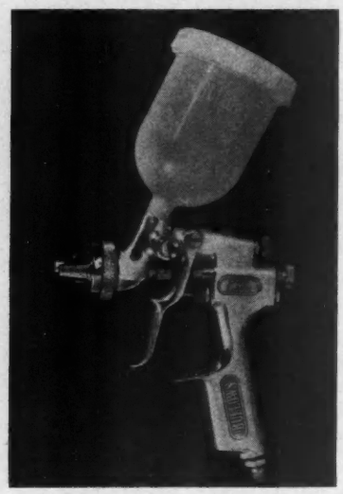
Ferranti Limited, Hollinwood, Lancashire.

Nylon Cups for Paint Spray Gun

The paint spray gun shown here is fitted with a nylon cup of ¾ pint capacity. The nylon cup is one of two sizes which have been introduced by Alfred Bullows and Sons for use on their L600 top feed spray gun. A larger 1¼ pint cup is also offered.

The new nylon cups weigh only 2¼ and 4½ oz compared with 8½ and 14½ oz for metal cups of identical capacities, comment Bullows. This substantial reduction in weight gives greater freedom of movement and considerably reduces operator fatigue.

The nylon cups are impervious to attack by most known solvents and they are claimed not to dent. Both sizes have screw-on nylon lids with a sealing device which obviates the need for lid gaskets.



Alfred Bullows and Sons Limited, Long Street, Walsall, Staffs.

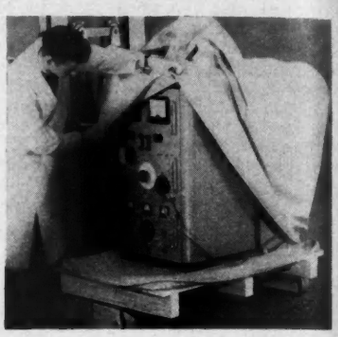
Plastic Pallet Cover With Closure

Export Packing Services say that the pallet is being increasingly recognized as an economical means for batch handling, storing and transporting of a wide variety of products. They are now producing a heavy duty reusable cover which may be attached to a pallet to enable the user to store and transport goods in adverse weather conditions.

The cover, as shown here, is made from plastic sheeting and is a development of the type already in use for the preservation of aero engines. Incorporated into the cover is an inspection window behind which is situated a humidity indicator to allow checks to be made on the relative humidity inside the pack. Alternatively an electric humidity indicator such as developed for the company's Driclad system can be used.

The covers are fitted with a closure made of two mating plastic sections and it is possible to provide an endless seal. Thus, comment the company, one portion of the cover can be completely separated from the other. The lower portion of the cover is either permanently fixed to the pallet or dropped on when required, the goods are loaded, and the upper portion of the cover is placed over the goods. By means of a specially designed slider the seal is then closed and the load is ready for transit or storage. The upper portions of the cover can be of various heights.

A strong nylon net can be used with the pallet to hold the goods firmly inside the cover.



Export Packing Service Limited, 56 Kingsway, London WC2.

Spigot-and-Socket Joints in Epoxy

For making spigot-and-socket joints in chemical stoneware or glazed earthenware carrying corrosive chemicals, F. Haworth now offer their Epilon system which is based on epoxy resins.

This system involves applying three sealing layers: the first is a chemically resistant compound; the second is made of impregnated long fibre asbestos which allows for lining up before final sealing; the final seal secures the pipes.

The makers claim that the system gives tremendous adhesion on the joint faces so that removal of glaze is unnecessary. Shrinkage is said to be negligible which means that joints are liquor-tight. They will be ready for use within 72 hours.

The physical strength of completed joints permits smaller diameter pipes to be joined several at a time away from the trench, say the makers.

F. Haworth (ARC) Limited, 40 Buckingham Palace Road, London SW1.

Pilot Production of Polypropylene Yarn

ICI say they have started production of Ulstron, their new high tenacity polypropylene filament yarn, on a pilot plant at the company's Wilton works in North Yorkshire. The first full-scale plant, with a capacity of 5 million lb a year, will commence production at Wilton by the end of the year, they add, and extensions will be built as required at the company's new site at Kilroot in Northern Ireland.

Since August, 1960, when they obtained from Montecatini of Italy the rights for manufacture and sale in the UK of polypropylene fibres, ICI have been carrying out development work on polypropylene yarns. The first commercial uses of Ulstron high-tenacity multi-filament yarn will be for fishnetting, twines and ropes.

The price of Ulstron, which ICI consider is low at 7*s* to 8*s* a lb, coupled with its low specific gravity, are expected to result in considerable economies for marine use over other synthetic fibres.

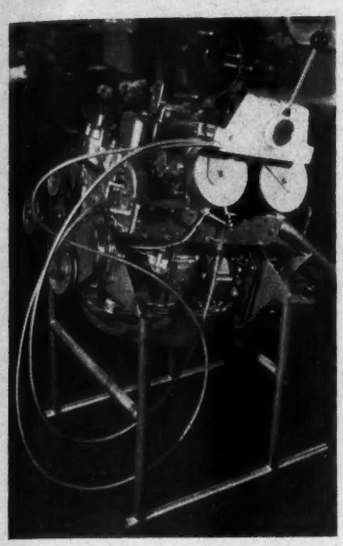
ICI expect that ropes made from the new yarn will be on the market early next year. Ulstron monofilament yarn is available in small quantities for market evaluation, and will eventually be used in similar outlets.

Polypropylene combines great strength, extreme lightness and negligible water absorption, say ICI. By special production techniques ICI

claim to have succeeded in making Ulstron high-tenacity filament yarn stronger than any other polypropylene yarns currently being produced elsewhere in the world. The makers expect that this filament yarn will become one of the major industrial yarns in this country.
Imperial Chemical Industries Limited, Millbank, London SW1.

Control Cable Lined With Polyethylene

The control cables shown fitted to this engine are made by Teleflex Products. The lining of the cables is made of an extruded tube of high density polyethylene supplied by British Resin Products. This company comment that because the poly-



ethylene tube has a smooth surface it allows complete freedom of movement of the cable inside. They claim a long trouble-free working life.
Teleflex Products Limited, Basildon, Essex.

Constant Temperature in Plastic Modules

The transistorized drive complex announced by Decca Radar some months ago is housed in modules developed by Decca and Precision Reinforced Mouldings Limited. The usefulness of transistors in this application depends on their

working in a finely regulated temperature which is claimed to be constant within $\pm\frac{1}{4}$° C at controlled humidity.

The modules consist of polyester resin reinforced with glass fibre around a light alloy frame. They are claimed to be able to withstand 30*g*. An infilling of rigid foam is used to increase thermal insulation. Precision Reinforced Mouldings say that this construction was chosen to provide great strength with low thermal conductivity in the minimum space. From the accompanying illustration the makers ask one to note that each module is made in one piece. With each one is a cold plate frame, three covers and a door.

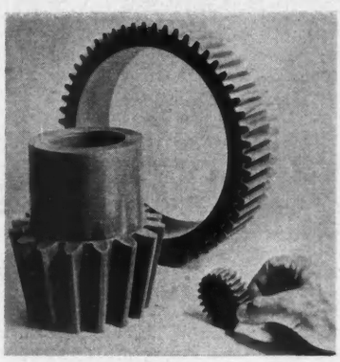
The specifications called for close tolerances of $\pm\frac{1}{64}$ in and $\pm 0{\cdot}005$ in, and techniques had to be developed so that these could be met. Twenty-one tools were required, some of the parts being laminated by hand and others pressed.
Precision Reinforced Mouldings Limited, Tolpits Lane, Watford, Herts.

Large Nylon Castings Now Available

For some six months past, Polypenco have been offering a grade of nylon called MC nylon. This stands for "monomer cast", which does not really explain the importance of the advance. By this process Polypenco expect to be able to supply nylon *castings* of unlimited size and weight, even running into tons.

The illustration here is of American origin and shows three large nylon gears cast in this nylon by the parent company, Polymer Corporation. The material is a type 6 nylon with physical properties which Polypenco describe as spanning the range of properties obtainable in nearly all nylons in industrial use today.

When considering making a part in nylon there is no need with the new process to think in terms of having to tool up for injection moulding. Polypenco are working in collaboration with a metal foundry who produce cast moulds from



drawings or customers' patterns into which the nylon is cast. The process takes place at atmospheric pressure, for the formulation is a simple two-part monomer and catalyst system which cures as soon as the parts are mixed and held at a certain temperature. Polypenco say that shrinkage on curing is negligible and that surface reproduction is very good,

Cost is described as being substantially lower than that of comparable stainless steel or brass castings. In the next few years Polypenco expect the cost to be halved from the present level making MC nylon competitive with carbon steel and aluminium castings.
Polypenco Limited, 68-70 Tewin Road, Welwyn Garden City, Herts.

Plastic Grids in Trickling Filter

Pilot scale researches into the efficiency of plastic grids to replace slag or rock used in trickling filters have led to the installation of a new trickling filter at the mill of Rome Kraft Company in America. This filter is octagonal in shape, is 80 ft across and 30 ft high. Within it are 6,250 plastic grids each measuring 2 ft by 2 ft by 4 ft. The total weight of plastic grids is 185 tons.

The researches were undertaken by Mead Corporation with the cooperation of Rome Kraft, and a report on their tests has been released. These tests were performed on commercially available grids known as Dowpac, made by Dow Chemical Company, and Polygrid supplied by the Fluor Corporation. These two commercial products are made from polystyrene or Saran (a modified polyethylene), yet the grids installed in the full-scale unit are made from pvc to a pattern shown in the illustration. This change of basic material appears to be derived from technical considerations in that polystyrene is attacked by turpentine, an ingredient in most kraft mill waste waters. Also certain plastic materials tested lacked structural bonding within the grids.

This filter unit is reported to be successfully treating 16 million gallons a day of kraft mill

waste, reducing the biochemical oxygen demand (BOD) enough to permit discharge into a stream following clarification by settling. The plastic grids have been shown to have less resistance to air flow and increased surface area compared with rock fills.
Mead Corporation, Chillicothe, Ohio, USA.
Rome Kraft Company, Rome, Georgia, USA.

Porous Plastic Holds Desiccant

Ideally the space between panes of glass in double glazing panels should be airtight and waterproof. From a practical point of view this is virtually impossible with the result that condensation and misting occur between the panes. Such are the comments of Porous Plastics of Dagenham Dock who supply tubes of Vyon, a porous polyethylene product, for making desiccators for double glazed units.

The units are produced by Silica Gel Limited. When used as a desiccant container, Vyon tube of $\frac{3}{8}$ or $\frac{1}{2}$ in bore and up to 12 in long is filled with silica gel and the tube is sealed at both ends. This complete unit is then clipped into position at the base of the window in between the two panes of glass.

Porous Plastics say that such units are being extensively used in heating and ventilating, in large refrigerated show-cases and in cold storage rooms. At Weeks Hall, a hall of residence for the Imperial College of Science and Technology, internal double-glazed fanlights are used for sound insulation between the warden's study and the housekeeper's office and the entrance hall. One of these desiccator units is used there.
Silica Gel Limited, Shaftesbury Avenue, London W1.

Controlling Japan's Rivers

Japan's rainfall approaches 100 inches a year and extensive river control works have always been necessary. Many large dams, particularly for multi-purpose schemes, have been built. Some recent projects are described.

RAINFALL in Japan is of the order of 100 inches a year. Heavy industrialization has called for the development of extensive hydro-electric schemes and the construction of many large dams. On the occasion of the Seventh Congress of the International Congress on Large Dams, held in Rome, the Japanese National Committee issued a booklet *Dams in Japan—1960* dealing particularly with work since 1958; the booklet is copiously illustrated and details of recent work are tabulated.

The trends in Japan over the past several years are the increasing number of multi-purpose dams; the construction of hydro-electric plants, with the output controlled by reservoirs or regulating ponds, to meet growing demands for power; and irrigation dams to supply water for paddy fields and land improvement projects.

The history of dam construction in the country can be traced back more than 1,000 years. Apart from over 2,000 earth dams in existence, the construction of concrete dams, principally gravity structures and a few butress dams of flat slab deck type, flourished from 1900 to 1950. Construction of rock-fill, arch and hollow gravity structures started around 1950. To mention structures over 60 metres (nearly 200 ft) in height, 36 gravity, 3 arch and 1 hollow gravity dams were constructed by 1958. Those completed after 1958 and under construction are 26 gravity, 15 arch, 6 hollow gravity and 3 rock-fill structures; the variety of the structures being built is a feature of recent dam construction activities in Japan. The work undertaken since 1958 is summarized in the table opposite.

Experiments and studies on dams are conducted at the Public Works Research Institute of the Ministry of Construction if the structure is for multiple purposes, the Technical Research Laboratory of the Central Research Institute of Electric Power Industry for power generation, and the Hydraulic Laboratory of the Ministry of Agriculture and Forestry for irrigation. Most of the universities have research laboratories where supplementary experiments and studies are made. The enlargement and improvement of research facilities and the marked progress in model testing technique at these laboratories are achievements which, with developments in foundation treatment, construction practice and measurements of structural behaviour, have contributed much in the construction of the various type of dams.

Multi-Purpose Dams

The Japanese Islands are influenced by a rainy season called "baiu " which continues for about a month beginning from the second week in June and by typhoons which strike the islands from summer to autumn. During those periods rainfall is extremely heavy and frequently over 500 mm (20 in) fall in 24 hours. This heavy rainfall immediately swells rivers causing destructive floods along their banks. Flood discharge of rivers in Japan are several hundred times the low run-off. The effective utilization and control of water by the construction of multiple purpose dams is becoming increasingly important.

Multi-purpose dams are constructed by the Ministry of Construction and prefectural governments. The dams serve the purpose of flood control, irrigation, municipal and industrial water supply and power generation for the maximum utilization of river water. The construction of multi-purpose dams is an important element of the national economy as a result of the growth of industrial activities, principally of the manufacturing industries, increase of population and rise in the living standard of the people. Since 1950, multi-purpose dams completed number 45, of which 13 projects have been completed in and after 1958; and under construction are a further 27 dams. Benefits created by the 72 dams completed or under construction are estimated to reduce flood damages by 8·9 billion Yen annually (£10 million), increase the production of rice and wheat by 140,000 tons annually through irrigation, produce 5·6 million MWh of electricity annually and supply 75 million cu. ft of municipal and industrial water each day.

Hydro-Electric Power

The hydro-electric potentials of the country are estimated to be 35,000 MW of maximum output and 130 million MWh annually in energy output. To date, approximately 30 per cent in power and 45 per cent in energy of the potential have been developed. Development of hydro-electric power is undertaken mainly by nine private power companies that each have specified service territories and the Electric Power Development Company, and also by some prefectural governments and industrial concerns.

Addition of generating capacity is made each year to cope with the growing demand for electricity. The growth in demand during the years 1957 to 1960 showed an average annual increase of 13 per cent in maximum power. The trend in the expansion of capacity is the growing importance of thermal power as a result of technological developments and the decreasing number of hydro-electric sites that can be developed economically. Up to comparatively recent times, steam power was principally employed only to supplement the deficiency in output of hydro-electric power, but newly constructed thermal plants are operated to supply base loads and peak demands are supplied from the hydro-electric plants with large storage reservoirs. The new thermal plants have a thermal efficiency of 39 per cent and a plant with a unit capacity of 350MW is being built.

As of April, 1960, the total installed maximum capacity was 21,170 MW and the total annual energy output 99 million MWh. Of the total capacity, 11,408 MW (54 per cent) was hydro-electric power which produced 62 million MWh (62 per cent). In the two years from April, 1958, to March, 1960, 1,152 MW in maximum capacity were completed. This addition of capacity consists of 485 MW that is controlled by reservoirs, 458 MW that is controlled by regulating ponds and 209 MW of run-of-river plant.

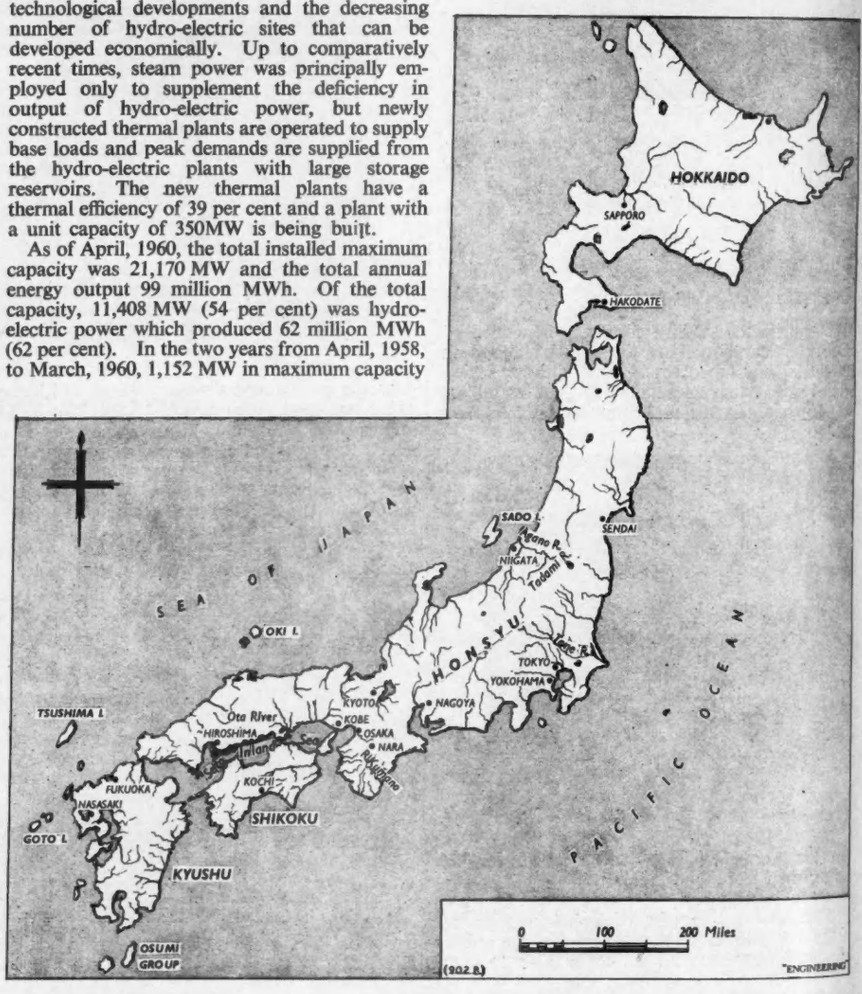
Approximately 60 per cent of the country's cultivated area or 3·5 million hectares are paddy fields. Irrigation water for 38 per cent of the total paddy field area is supplied from reservoirs and ranks second to natural flow from rivers. Cultivated area per farm family is a meagre 1 hectare (nearly 2½ acres). The over emphasis on paddy fields and small-holdings is the feature of the agriculture industry in Japan.

Conversion to dairy farming and improvement of plant species are noteworthy accomplishments and, to fully utilize these accomplishments, land improvement projects are being carried out. These include the improvement of water uses in paddy fields, the irrigation of farmland which was neglected in the past, and the installation of irrigation and drainage systems to permit the alternating rotation of paddy field and farmland cultivation. The source of water is either storage dams or subterranean water.

The Ministry of Agriculture and Forestry, prefectural governments and public corporations have under construction 94 dams for agricultural uses, including three dams that also provide power generation and water supply.

Ota River Projects

The Ota River empties into the Seto Inland Sea near the city of Hiroshima. The hydro-electric potentials of the river were exploited from around 1920. In addition to two large dams—Tateiwa and Odomari—on the upper flow, the Chugoku Electric Power Company in 1958 completed the Tarudoko Dam, 130 ft high, on the Shibaki River, a tributary of the Ota.



As considerable water was spilled at the Odomari Dam, heightening of the dam by 35 ft to 240 ft to double its storage capacity was begun in 1956 and completed in 1959 by the Chugoku Company; the heightened dam is shown in the illustration. In preparing the construction plans for the heightening of the dam, leakage of water from the old dam, bonding of new and old concrete and other problems were studied. Since completion, however, leakage of water or other defects that may affect the stability of the dam have not been observed.

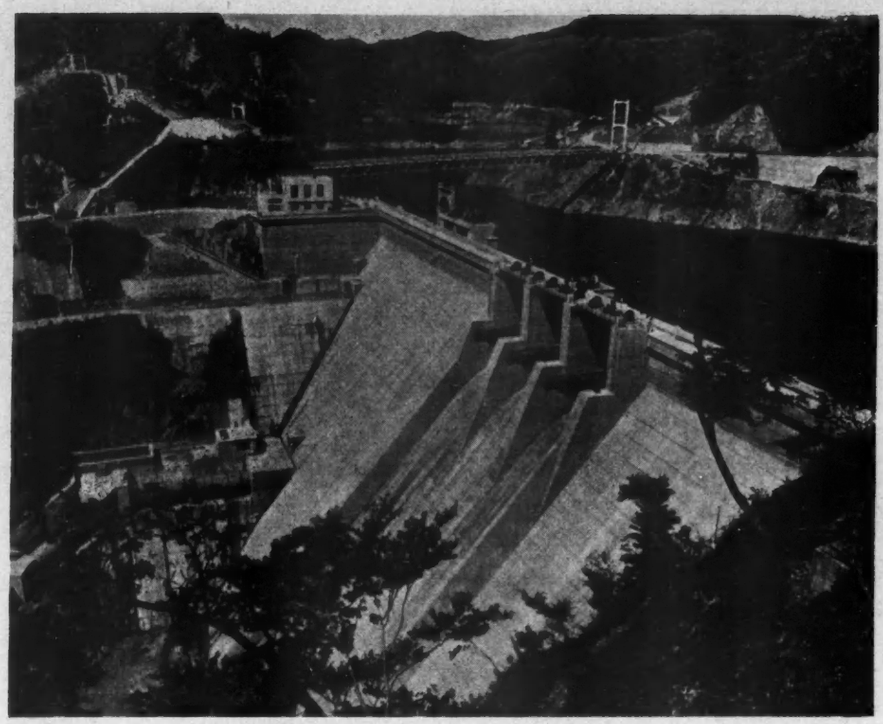
With the regulation of the river flow by the three storage dams, the hydro-electric potentials of the river was re-examined. As a result of the study, 87·3 MW of capacity is under development by the extension of existing plants and construction of a new plant. Completion of this programme, scheduled for this year, brings the total output of the Ota River to 214·8 MW.

Manno-Ike Dam

The Manno-Ike Dam is an earth-fill structure for irrigation purposes constructed on a small river in the western section of the island of Shikoku facing the Seto Inland Sea.

The dam was originally built around AD 700, washed away in AD 820 and rebuilt by a famous Buddhist monk. The dam was again destroyed in 1040 and 1853. The failure in the earthquake of 1853 is believed to have been caused by the destruction of a bottom outlet of masonry in the dam body.

The dam was rebuilt in 1870 to a height of approximately 80 ft. In 1959, Kagawa Prefectural Government heightened the dam by 20 ft to double its storage capacity.



Odomari dam on the Ota River was heightened by 35 ft to 240 ft to double reservoir capacity.

Tadami River Projects

The Tadami River, a tributary of the Agano River which is a large river emptying into the Japan Sea, flows through a mountainous district where snowfall is extremely heavy. As a result, the run-off is rich but the river is frequently menaced with floods during the spring thawing season.

From decades ago, much was done to develop the rich potentials for hydro-electric power. Eleven hydro-electric projects with an aggregate maximum capacity of 570 MW have been developed by the Tohoku Electric Power Company. All of these projects are below 1,000 ft above sea level in the middle and lower reaches of the river. The upper flow remained undeveloped because of snow as deep as 20 ft which isolates traffic half of the year and disastrous floods during the spring thawing season.

The Electric Power Development Company undertook the development of the upper reaches of the Tadami River in 1956. The first project is the Tagokura Dam, 465 ft high, creating as reservoir which is 1,620 ft above the sea at full water level. A 20 mile long railway was constructed along the bank of the river to transport all materials and supplies. The Tagokura Dam, together with the powerhouse with a maximum installed capacity of 285 MW (ultimately 380 MW) were completed in June, 1960.

Upstream of the Tagokura Dam, the Electric Power Development Company has under construction the Okutadami Dam, a concrete gravity structure (520 ft high) with the reservoir 2,500 ft above the sea at full water level. An access road 20 miles long (including 10 miles of tunnels) was constructed through a mountain which forms the western divide of the Tadami River.

Commercial operation of the Okutadami Power Plant (maximum capacity 360 MW) began in November, 1960. On completion of the Okutadami Dam, the output of Tagokura Power Plant will be increased to 380 MW.

An extensive development programme of the upper reaches of the Tadami River, including tributaries, as well as the utilization of undeveloped head on the lower course of the river, is being planned. When the development scheme of the Tadami River is completed, the entire head between elevations, 4,700 ft and 110 ft, near the river's estuary will be utilized for hydro-electric power by approximately 20 dams, including a pump storage project. The river will ultimately produce about 2,200 MW of power.

Tone River Projects

The Tone River, with a drainage area of 600 sq. miles, is the largest river in Japan. The lower reaches of the river flow through the Kanto Plain which embodies the metropolitan city of Tokyo.

The Tone River is one of the most extensively developed rivers in Japan, and is utilized for irrigation, water supply, power generation as well as navigation. However, flood and draught, the common features of all rivers in Japan, are not an exception to the Tone River, where a maximum flood flow was 600,000 cusecs recorded at Yattajima in September, 1947, and the minimum flow was 240 cusecs at Kurihashi in July, 1958. In view of the streamflow condition of the Tone River, the Ministry of Construction has under way a major programme to control the flow of the river.

The flood control of the river is based on the 600,000 cusecs flow at Yattajima. The scheme is to control 105,000 cusecs by a series of dams on the upper reaches and 400 cusecs by the improvement of the river channel.

The dams on the upper stream will serve the multiple purpose of flood control and store water to supplement the needs of existing water users, and to supply 630 cusecs of municipal water plus 350 cusecs of industrial water to the vicinity of Tokyo, and 1,200 cusecs of irrigation water in the plains along the middle flow that it is anticipated will be required by 1970.

The multi-purpose dam construction on the tributary, Kinu River, includes a scheme to reduce flood flows of 184,000 cusecs per sec by 49,000 cusecs and to increase the minimum flow by 950 cusecs to supply water for irrigation purpose.

All the dams will have hydro-electric plants, including a pump storage scheme that will produce peak power. The project is scheduled to be completed in the next ten years.

Kumano River Projects

The Kumano River which flows in the Kii Peninsula and empties into the Pacific Ocean, is about 100 miles long with a drainage basin of 900 sq. miles. The Kii Peninsula is one of the wettest districts in Japan and the annual rainfall in the mountain district exceeds 180 in. Being close to the Osaka and Nagoya industrial districts, harnessing the rich hydro-electric potentials of the Kumano River was considered for decades. However, the precipitous terrain and frequent typhoons, which cause flash floods of over 350,000 cusecs, hindered development.

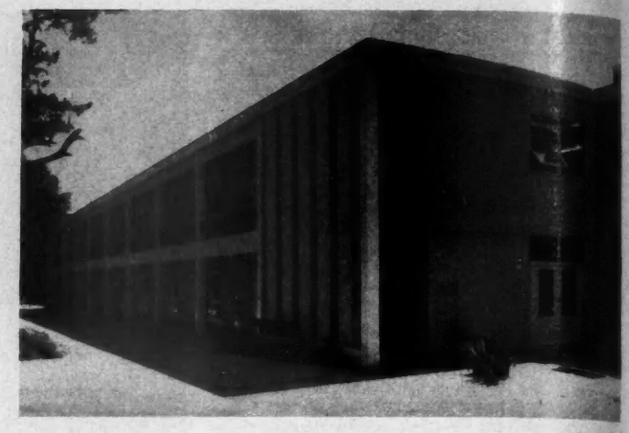
Development of the Kumano River was undertaken by Electric Power Development Company, beginning in July, 1958, with the construction of the Kazaya Dam. Since then, work has started also on the Futatsuno and Sakamoto Dams. Upon completion of the programme, approximately 600 MW of hydro-electric power will be harnessed in about ten large dams, in addition to the benefits of reducing flood damage. Diversion of water from the upstream to another basin for irrigation is also included in the scheme.

A variety of dams are to be built on the river. Kazaya, Sarutani, Nanairo and Kurobuchi are straight concrete gravity structures; Ikehara, Sakamoto, Okutoro and Futatsuno are arch dams; Kuchisubo a rock-fill dam with a concrete centre spillway; and Hizue is a floating dam. The Ikehara Project, the principal dam, includes a pump storage plant of 240 MW.

TABLE: *Dams Completed and Under Construction Since* 1958

Type / Purpose	Gravity c	Gravity u	Arch c	Arch u	Buttress c	Buttress u	Rock-fill c	Rock-fill u	Earth-fill c	Earth-fill u	Total c	Total u	Grand Total
Multi-purpose ..	16	33	3	9	1	3	—	2	4	10	24	57	81
Irrigation	7	11	1	1	—	—	2	1	24	34	34	47	81
Power generation ..	25	30	5	15	2	3	—	1	1	—	33	49	82
Total	48	74	9	25	3	6	2	4	29	44	91	153	244

Abbreviations: c—completed u—under construction Remark: Buttress type dams are of the hollow gravity type



Two new buildings at the Cement and Concrete Association research station, Wexham Springs. (Left) Front elevation and entrance to the Materials building, showing the use of sawn and split blocks. (Right) Front elevation of the Services building with a two-storey colonnade.

Variations Using Cement and Concrete

Two new buildings, for materials and services, have recently been added to the Research Station of the Cement and Concrete Association at Wexham Springs, Buckinghamshire. Since the Association took over the grounds in 1949, six new buildings have been added, and this completes the present planned development for the station.

The materials building is L-shaped in plan and stands two stories high. It is approached from two sides through paved and planted courtyards which have been landscaped. The laboratories are housed in the longer wing, in most cases facing north to avoid the direct sunlight.

The structure is of *in situ* reinforced concrete with flat slab floors supported by reinforced concrete columns. Columns are spaced at 11 ft 5 in centres longitudinally and 16 ft 6 in transversely; beams are used only in a few exceptional cases. The external walls are of concrete-block cavity construction with an inner leaf of foamed lightweight concrete blocks.

The concrete finishes to the outside façade make an unusual and interesting study, as is shown in the left hand illustration. The main areas of walling are faced with split silver-grey concrete blocks made with ordinary Portland cement and Cornish de Lank granite. In contrast, the panels below the windows are faced with smooth sawn concrete blocks of deep charcoal grey; these are made with black cement and black Clatchard whinstone aggregate, with a sprinkling of Cornish granite. Both types of block are hydraulically pressed to 16 in by 4 in by 4 in thick, and laid with a $\frac{3}{8}$ in joint. The *in situ* concrete at first floor level is made with white cement and Derbyshire Spar aggregate and has been bush hammered. The parapet extending round the laboratory wing was cast against rough sawn boarding to give a pronounced surface texture. In the laboratory wing, concrete mullions for the windows were cast with black cement and Shap granite aggregate, and the surface treated with two coats of transparent sealer.

Inside the building the concrete block treatment is continued into the entrance hall which is faced with vertically-grooved blocks. The surface is white cement and sand, patterned by pressing a board fitted with plywood strips into the wet concrete. The flooring in the hall is standard concrete flags linking the paved areas of the courtyards on either side of the building. Most of the solid partitioning in the building is foamed lightweight concrete blocks. In the laboratories, these blocks and the inner leaf of the concrete wall are built fair-faced and painted with "Sandtex." The new product, "Spectra Glaze" plastic faced concrete blocks, have been used in the toilets. The roofs of the laboratory wing are lined with wood-wool, and the floors have a granolithic finish. In the offices acoustic tiles were stuck direct to the slab soffits and the floors are paved with thermoplastic tiles.

There are two internal staircases, both of *in situ* concrete. One is a helical stair rising through the central hallway with a radially board-marked soffit and smooth edges cast against plywood. Treads and risers have a sheet vinyl covering which was stuck directly to the concrete. The ground-floor laboratories plus three on the first floor are all air-conditioned; the latter are used for work on shrinkage, creep and cement tests and have been designed for very close temperature and humidity control. In the remaining laboratories, a constant temperature of $66° \pm 2°$ F is maintained at 65 per cent relative humidity.

The services building is a two-storey T-shaped block constructed largely of "Siporex" lightweight concrete slabs which give good thermal insulation. It is a multi-purpose building with stores, workshops, laboratories and a printing department. A two-storey colonnade, mostly of prestressed concrete construction, extends along the north face of the building. The main part of the building has an *in situ* reinforced concrete frame up to the first floor level, with a central line of columns; the latter are continued to roof level and support a spine beam. The first floor slab is constructed of "Stahlton" prestressed concrete units spanning 20 ft. The remainder of the construction is entirely of Siporex, with storey-height slabs 8 in thick forming the external cladding. The roof is finished with "Flexophalte" laid directly on the slabs. The external slabs of the main block are sprayed with "Sicrol U" waterproofing agent, light blue in colour, contrasting with a deep terracotta rendering for the aggregate preparation section.

The main contractor for the materials building was William Hartley and Sons (Wexham) Limited with Truscon Limited as sub-contractors for the reinforced concrete, and for the services building Richard Costain (Construction) Limited.

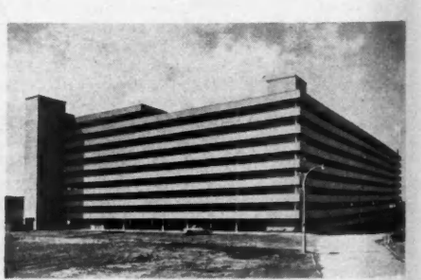
BMC Car Park Holds 3,300 Vehicles

In an agreement with the Board of Trade at the beginning of last year the British Motor Corporation announced a £49 million expansion plan to raise the production from 750,000 vehicles a year to 1,000,000 a year by the end of 1962. It was proposed that three new factories should be built: in Scotland, Merseyside and West South Wales. The complete heavy commercial vehicle and tractor production will be transferred from Longbridge, Birmingham, to the Scottish factory, giving employment to 5,600 people. To get the best return from the ground area available in the Birmingham area, the construction of a vertical car park was considered to store the cars before delivery to the agents, so that the previous site for cars awaiting collection could be used for a new assembly plant.

A new nine storey building, costing £550,000 and housing 3,300 cars, has been built, measuring 384 ft long by 204 ft wide, with the top floor 72 ft above ground; the site occupies two acres and the total area available for parking is 17 acres. The building incorporates a ramped floor principle of operation, which enables upward and downward movements to be completely segregated. A car driven at a constant speed of 5 mph takes eight minutes to travel from the ground floor entrance to roof level, but as the drivers will all be experienced, and employed to drive the cars, this driving distance is not a serious problem. There are two lifts provided for use on the top three floors.

The vehicles are parked at right-angles on each side of a 20 ft runway; this requires 208 sq. ft per car against 256 sq. ft per car for angle parking for stances 16 ft by 8 ft. There are eight lines of parking stances across the width of the building, served by four roadways. A reduction in space has been made in the normal area taken up by the approach ramps by tilting the whole floor to a very slow gradient, so that the floor also forms part of the access ramp. There are two entrances to the building, the two ramps being arranged like a two-start thread, with cross-over links in the centre of the building.

In constructing the building the lift-slab principle was used, which was felt preferable to the post-beam and slab work, as the depth of the beams could be saved at the cost of slightly thicker slabs. The 350 ton slabs were lifted into position by 21 synchronized hydraulic jacks. Each floor has a balustrade wall to the normal window-sill height, restricting the openings to narrow slits. The balustrading is made of light embossed aluminium sheeting covered by coloured plastic sheets.



The nine-storey open-sided car park at the Longbridge factory of the British Motor Corporation, used for storing 3,300 cars before delivery.

Use of Aluminium in Fairgrounds

Ten years ago most fairground equipment was constructed from ferrous metals and wood, which meant heavy loads and often difficult manipulation, and also frequent maintenance. The use of aluminium has greatly reduced these problems since, properly specified, it does not corrode or decay and the need for maintenance is decreased.

This summer a new dodgem track has been operating at Fleetwood Amusement Park. The arena is 64 ft long by 40 ft wide and MG2 aluminium tubing and duralumin H-WP angles

Helter skelter built on a duralumin frame.

are used for the floor supports and roof structure. Wooden stanchion mountings are used to insulate the roof carrying the mesh conductor ceiling.

The manufacturers were Supercar Company (Coventry) Limited, of Leamington Spa, who used material supplied by James Booth Aluminium Limited. Another example is a helter skelter with a 45 ft high tower and maximum diameter of 25 ft. It is constructed from riveted duralumin H-WP sections; each section comprises an aluminium sheet fixed to a frame of aluminium alloy angle members. The spiral track is of wood with MG2 aluminium tubing.

James Booth Aluminium Limited, Argyle Street, Nechells, Birmingham 7.

Developments in Roofing

A new form of copper roofing is being manufactured by the Ruberoid Company Limited and will be on show at the Building Exhibition at Olympia, London (15 to 29 November). The roofing is manufactured from 42 gauge copper sheet with spherical indentations and a backing of filled bitumen. The design of the indentations does not induce stress points in the copper, and a wave form in all directions allows more efficient expansion and contraction, reducing the effect of any movement on the copper.

A new series of rooflights have been designed for use with Ruberoid insulated metal deck roofs, but they may also be used with other materials such as wood wool, strawboard, concrete, etc. The rooflights require no structural support or trimmers, and are provided with either single or double glazing. If the building requires fixed or controlled ventilation, integral louvres may be specified, which usually give an overall saving in cost compared with the conventional roof unit.

Alcan Industries Limited will be showing an improvement to the Noral Snaprib sheet with a new sealed-end effect. The ends of the sheet are folded to form an integral eaves or ridge filler, or both, and are watertight at very shallow pitches; it will also give greater rigidity against wind load. Similar advantages may be gained from sealed-end industrial sheet. A new paint finish will also shortly be available; it is baked-on vinyl coating, and due to an anodic surface pre-treatment, it will neither crack nor peel.

Ruberoid Company Limited, New Oxford Street, London, WC1.

Alcan Industries Limited, Banbury, Oxfordshire.

Hydro-electric Scheme in Malaya

A hydro-electric scheme which will eventually produce 320 million units of electricity per annum is now under construction in Cameron Highlands of Malaya. The works will use the waters of the Rivers Bertam and Telom, and will include 15 miles of tunnels, three diversion weirs, two power stations and about 110 miles of transmission lines.

The largest feature above the ground is the 120 ft high Ringlet Falls dam; about half the concrete has been poured and tipping of rock in the rockfill section at the right abutment has just begun. Impounding in the reservoir should start next year. Excavation for the large power station at Jor and about three-quarters of the tunnelling is complete, and concreting is in progress. Installation of the equipment will begin next month and the first two turbine sets are due for commissioning in February 1963.

When the scheme is complete the reservoir will hold 1,670 million gallons of water, and 70,000 tons of rock are being excavated. The estimated cost is 150 million Malayan dollars and is sponsored by the Central Electricity Authority of the Federation of Malaya. There is a supervising staff of 110 Europeans on the site and a labour force of 1,759 Malays, Chinese and Indians.

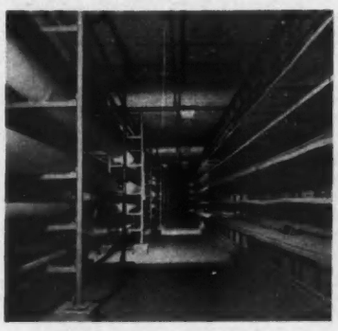
The consulting engineers are Preece, Cardew and Rider, and Binnie, Deacon and Gourley, both of London. The civil engineering contractors are Hochtief A.G.-Philipp Holzman A.G. of Germany.

"Unistruct" Inserts in Shell Centre

The large number of services in a building the size of the new Shell Centre calls for a complicated network of piping and wiring and the need for a support system which is standardized but sufficiently flexible to carry loads ranging from lightweight cables to heavy pipes.

The Shell Centre has 66 miles of under-floor heating, 22½ miles of plastic pipes, 250 telephones and nearly 4,000 extensions, and hundreds of miles of other pipes of varying diameter and wiring. It was decided to install the services in runs following the corridors, through special service ducts and in subways. A false-ceiling system conceals the services and provision has been made in height of each floor.

"Unistruct" inserts made by Sankey-Sheldon Limited have been set in with the concrete in the underside of every roof slab; they are easy to install and can bear heavy loads, though small in cross-section. The insert comprises a standard "Unistruct" box-section channel with an open slot along one face and fish-tail lays on the back face. A sealer strip is inserted into the open face of the insert which is then attached to the shuttering. Concrete is poured in and when set the shuttering is removed and the sealer strip withdrawn; this leaves a flush fitting from which various attachments may be located.



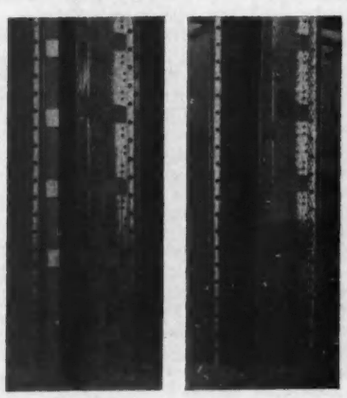
Most of the electrical installation is laid on trays held by the inserts, eliminating the normal fixing methods for the wiring and also cutting down installation time. The services subway connecting the two main blocks of the Centre was constructed so that no fixings could be made to either wall or ceiling. A simple framework structure using "Unistruct" P 1000 channel was installed and Rawlbolted to plinths at equal distances along the floor as shown in the illustration. Large diameter pipes are racked from floor to ceiling on one side of the subway and the cable carrying trays attached to open sides of the braced vertical channel on the other side.

Sankey-Sheldon Limited, 46 Cannon Street, London EC4.

Fire Protection for Structural Steelwork

What is claimed to be the simplest and fastest known method of providing a lightweight fire protection and plaster finish for structural steelwork is being shown for the first time at the Olympia Building Exhibition (15 to 29 November) by Metal Sections Limited. Known as the Beatfyre System, and based on the Beatfyre clip design, the components and arrangements are shown in the illustration.

The main features are speed of assembly—the clips are easily fixed to the flanges of RSJ's—and the immediate provision of a straight arris which gives a ready made depth guide for the plaster thickness. Normally, the clips do not require wiring in position. The use of lightweight protection is essential if structural steelwork is to be competitive; it enables the weight of the superstructure to be kept down, so reducing the size of columns and the size of the foundations required, thereby helping to cut costs.



On the left is the Beatfyre clip fitted to RSJ flanges; on the right the expanded metal has been wired to the clips and the column is ready for the plaster.

The company are also showing their Metsec Troughform—a permanent concrete shuttering—used to provide a base for concrete floors and flat roof slabs poured over steel joists and beams. The sheets are ribbed lengthways to give them rigidity and are laid across the joists to form a strong support ready for the concrete. Troughform sheets can be supplied in any lengths, and the width of each sheet is 13¾ in overall, giving an effective cover width of 12 in. Two types of sheet are available, ¾ in and 1⅛ in in depth, and each depth in four different gauges, 20, 22, 24 and 26 swg. Both types are produced with a cold-rolled general purpose finish or hot dipped galvanized.

Metal Sections Limited, Oldbury, Worcestershire.

On the Shelf

By Frank H. Smith

ENTERPRISE is shown by Advance Components Limited, Electronic Instrument Engineers, Roebuck Road, Hainault, Ilford, Essex. They publish *The Advance Science Master's Handbook*, by I. L. Muter (of Rotherham College of Technology), which shows how science masters and lecturers can use Advance instruments in their work. They say that all science masters on their mailing list have had a free copy and it would not surprise me if they are willing to add to that mailing list. Normally the book is 12*s* 6*d* but they have a special price (no qualification is given) of 7*s* 6*d*. Whichever way you look at it, any master who has to teach electronic engineers of the future has nothing to lose by having a copy.

Being a bit dim, I get confused about which US official documents one gets from USGPO and which from OTS (Office of Technical Services—not the better known On The Shelf), but certainly *Reactor Safety—a Literature Search* is obtainable from OTS at US Department of Commerce, Washington 25 (and you cannot get these through HMSO). The Atomic Energy Commission fathers it, and it lists 741 references to unclassified reports, showing each one's availability, price, and what-have-you. $1.75 cents, but I don't know how you get the money there or what the postage is. Remember the happy old days when radiation was something that heat did?

The Industrial Welfare Society (Robert Hyde House, 48 Bryanston Square, London W1) send out a release headed "What Every Supervisor Needs to Know"—a puff for the 1962 edition of the *IWS Supervisors' Handbook and Diary*. Before they start telling you what's in it they sing the praises of the binding with "high resistance to grease and oil smears—and it is washable too." Just the thing, in fact, for the kitchen where the supervisor does her best work. One of the chapters quoted in the list of contents is "how to behave at a meeting," which should go well with trade unionists. It might do me some good too. I never can get used to insulting that fool on the other side of the table through the chair. The handbook, by the way, has a seven days to a page diary, and for a little extra on the 5*s* cost, company names can be gold blocked.

One of the many things of which I am ignorant is the significance of Serial Numbers of Machine Tools but this (prefaced by Reference Book) is the title of a publication, particulars of which may be obtained from the British Association of Machine Tool Merchants, Lennox House, Norfolk Street, London WC2. I suppose if you happen to lose a machine tool or have one pinched from the car park, the serial number helps the police to get tabs on it?

A gentleman named Arthur Cayley wrote a lot of maths, which the CUP published in 13 volumes. These have been out of print for some time, but any library that has an urge to get Mr. Cayley on its shelf can now get them from Johnson Reprint Corp. (17 Old Queen Street, London SW1, and New York) at the equivalent of $325.

Being partial to balloons I liked the cover of the latest catalogue of Phoenix (10-13 Bedford Street, as I've remarked before). It is from *A History of Invention* by Egon Larsen and he seems to have compressed it into 352 pages for a guinea (pictures too). It's a young people's book (Christmas is coming, Uncle) as is *Modern Marvels of Science* by Sir Richard Keane, at 10*s* 6*d*.

Catalogues make strange bedfellows, but it's a long time since I saw a stranger juxtaposition than that in Dent's latest list. *The Love Songs and Heroines of Robert Burns* and Ogden Nash's *Collected Verse*: the one needing a translator and the other as lucid as they come (witness *his* approach to love—"Candy is dandy but Liquor is quicker").

Heat Flow

The Elements of Heat Flow. By D. A. WRANGHAM. *Chatto and Windus.* (70*s*)

A superficial assessment of this book creates the impression that it helps to fill the gap, for the undergraduate, between the extensive volumes available to the researcher and the restricted treatment given in many books on applied thermodynamics. It does, however, cover a much wider field than could be assimilated by an undergraduate unless he were studying heat transfer as a subject in his final year: often this is not the case, the subject being treated piecemeal fashion in an applied thermodynamics course spread over three years. Extending to nearly 500 pages, the book contains 16 chapters and closes with some useful tables of properties and an index. There are 130 fully worked examples and 100 problems with answers representing examination questions and actual problems from industry; these cover a very wide range, some requiring a good deal of time, practical experience and mathematical ability and are one of the better features of the book.

The opening chapter on units and dimensions is followed by three each on conduction, convection and radiation, two on heat exchangers and one each on extended surfaces, condensation, boiling and nuclear reactors. Nine of these chapters have bibliographies; but the total number of such references is only 32, with only four post-1950.

Heat transfer is an ever-expanding subject which, over recent years, has contributed much to the success of nuclear reactors, high speed flight, rocketry, space research, etc. The heat transfer technologist must be cognizant of the fact that, in breaking new ground, he may have to use logarithmic plots, extrapolations of experimental results, results from experiments which may be only remotely appropriate to the problem on hand; even with conventional problems he must appreciate that unknown factors, such as contact resistance, scaling, etc., result in answers which carry a "tolerance": in short, he must have a deep understanding of the problem. Bearing this in mind, it is difficult to decide what the two chapters on boiling and nuclear reactors are intended to achieve. The former covers only six pages, does not feature any diagrams and offers two formulae without any source being quoted (no responsible worker would use these formulae without investigating their pedigrees) and the latter makes a token attempt to relate neutron flux to heat generation rate in the fuel, but confuses a fuel element with a bare reactor core. Neither of these chapters has a bibliography.

Although the author recognizes that the subject is one requiring careful definitions of terms, dimensions and units, he fails to maintain control. Concerning terminology, many teachers will dislike the association of "heat" with "flow" (at one point, even, heat is said to "gravitate") and be even more disappointed to find "total heat" used for "enthalpy." On units and dimensions, chapter 1 does not augur well for what follows. "Pound (lb)" is used throughout for both force and mass and derived units are frequently expressed incorrectly; the units of coefficient of thermal conductivity appear in about a dozen different forms and those of viscosity include poise, lb.ft.hr., ft./hr. units. It is unfortunate that a few units with "names of dedication", such as poise, are too well established to be superseded; but, these apart, units ought to be expressed in a way to show dimensions too. To add to the confusion, there are so many changes of symbols in some sections as to exasperate the reader. For instance, n and η are used indiscriminately to denote "a number of tubes" in a solution which also uses η for "viscosity"; generally, both n and η are used for "viscosity".

The preface states that the book has developed from lecture notes: this is all too obvious. There are many "equations" which a student might write hurriedly in a notebook which are not equations at all; for example, in demonstrating that the Nusselt Number is non-dimensional, the author obtains: $Nu = 1$. In all, there are over 200 errors ranging from the typographical, showing perfunctory proof-reading, to the more serious, suggesting careless checking of the manuscript.

It is regrettable that the favourable first impression of the book should have to be reversed by the inexcusably large number of errors.

B. J. JEFFERY

Structure Analysis

Statically Indeterminate Structural Analysis. By R. L. SANKS. *Ronald Press Company, 15 East 26th Street, New York 10.* ($10)

This is a text-book written by a teacher of the subject (the author is Professor, Civil Engineering Department, Gonzaga University) for undergraduate courses and suitable, the author considers, for graduate courses and reference purposes. The author presumably has American undergradate students and curriculae in mind but it can be stated at once that for United Kingdom universities the book is not written to a high standard for undergraduates and is not considered sufficiently advanced for post-graduate studies.

The book is written in six parts; a short "Review of Fundamentals" (42 pp.), "Moment Area" (76 pp.), "Virtual Work" (106 pp.), "Moment Distribution" (104 pp.), "Other Methods" (64 pp.), and "Models" (54 pp.), and the treatment throughout is essentially graphical, the mathematics used being kept to a minimum, both in quantity and level. In his preface the author states that he has found advantages in "approaching the subject by method (e.g. virtual work) rather than by problem type (e.g. truss deflexion)," but surely the approach should be to teach basic theory. The various methods available to translate theory into a practical form of analysis should be covered but the choice can well be left to personal preference and suitability *vis-à-vis* the problem. The author concentrates largely on virtual work and moment distribution. The importance of the latter is not denied but the author does not illustrate the fundamental differences between this type of numerical solution and the general type of solutions. This lack of differentiation illustrates the general background of the book. It is doubtful whether virtual work is as important or profound a method of analysis (considering the others available) as the author considers. The treatment of Castigliano's two theorems in only six pages (under "Other Methods") makes its own commentary on the value of the book.

The basic problem of teaching theory of structures (in this case the analysis of statically indeterminate structures) is one of approach and language. One method is to use geometrical and trigonometrical concepts in the elucidation of structural deformations and, at each terminal stage, transfer the results into mathematical language (mainly calculus). Secondly, there is the reverse technique whereby the arguments and developments of the theorems covering structural behaviour are presented step by step in mathematical language. In each case a "breakthrough" must occur in the student's mind whereby he can visualize the physical counterpart of his mathematical language—or

vice versa—if his wider application of structural theorems is not to be limited in his post-collegiate years. The author is an exponent of the former method above. However, given that the function of an undergraduate course is to teach fundamentals, that the basic discipline of an engineering undergraduate is a mathematical one and that the teaching and student assimilation of mathematics keep in step with the teaching of theory of structures, it is considered that the second technique above is preferable and will result in a better standard of graduates.

A simple illustration of the difference in the two methods is shown in the derivations of the basic slope and deflexion formulae. This can follow immediately from the basic flexure derivations.

Thus, having established $\frac{M}{EI} = \frac{1}{R}$ (the derivation of this is given by the author in an appendix); then $\frac{M}{EI} = \frac{d^2y}{dx^2}$ (for a straight beam), and $\theta x = \int_0^x \frac{M}{EI}\,dx$ (the angular change at point x with respect to point 0), and ignoring the tangent "throw" $\theta_0 x_1$.

$$y_1 = \int_0^{x_1}\int_0^x \frac{M}{EI}\,dx\,dx = \int_0^{x_1}(x_1 - x)\frac{M}{EI}\,dx$$

i.e., deflexion at point 1 with respect to tangent at point 0 or (if $\theta_0 x_1$ be added) with respect to point 0.

The above is an elegant and simple derivation of two fundamental formulae and one that should be perfectly viable for undergraduates who also take an undergraduate mathematics course. The author uses a laborious and mainly trigonometrical treatment to establish the same identities.

The section on moment distribution is well and thoroughly presented. The reproduction of the Portland Cement Association's tables of frame constants is useful. The book is excellently produced with diagrams of exemplary clarity, numerous set problems with answers to selected problems, sufficient worked examples for illustrative purposes and an index. The reader may be conscious of a certain disjointedness resulting from the method and the substance of the presentation. On an *ad hoc* basis the book may be useful for reference purposes on the actual techniques dealt with, i.e., mainly virtual work and moment distribution. It is unlikely that the book will find a permanent place amongst engineers (or students), in view of the numerous textbooks on the subject available in this country.

A. GOLDSTEIN

The Halcyon Days

The Workshop of the World: British Economic History from 1820-1880. By J. D. CHAMBERS. *Oxford University Press.* (8*s* 6*d*)

The Home University Library has for long had the reputation of publishing high quality material at modest prices. This book is no exception. It deals with British economic history over the years 1820 to 1880. Apart from its readability, its main claims to success are Professor Chambers' ability to select as his main topics themes which enable the reader to see the wood from the trees and, especially useful to the older reader, to have the advantage of comparatively recent research in economic history assimilated by the author and woven into the text.

At first sight it may not seem very important for the engineer to have at his disposal good, concisely written economic history of the recent past. But we are getting back to the old idea that the engineer, as in the 18th century, for example, sees his work against the general cultural, economic and political background of his times. In these pages the engineer of today can see the way in which balance of payments problems, the phenomenal thrift of the middle classes, the organization of the workers in a rudimentary form and the acceleration of the enclosure movement in the countryside affected the general economic wellbeing of the country a century ago. He sees that the problems of the second half of the nineteenth century for those who guided public policy have a familiar ring for today.

Perhaps the greatest single merit of the book is the warning it suggests about easy generalizations. A hundred years ago the landed interests, the manufacturers, the agricultural labourers were much less homogeneous as groups than most of us have been brought up to think. Their interests among themselves were much less common and free of contradictions than we are apt to think today. Types and interests fitted less tidily than the older textbooks say into categories for mental pigeonholing.

The book is very clear on the effect of developing technology on the growth and decline of industries, and how different localities responded to the challenge of accelerating technical change. These problems are very relevant for today.

The book concludes with a useful bibliography and an adequate index.

G. E. TEWSON

Pure and Impure

A Physics Anthology. Edited by NORMAN CLARKE. *Published for the Institute of Physics by Chapman and Hall.* (35*s*)

The New Age in Physics. By SIR HARRIE MASSEY. *Elek Books.* (42*s*)

Progress in Nuclear Physics. Volume 8. Edited by O. R. FRISCH. *Pergamon Press.* (90*s*)

Kinematics of Nuclear Reactions. By A. M. BALDIN, V. I. GOL'DANSKII and I. L. ROZENTHAL. *Pergamon Press.* (42*s*)

Practical Nucleonics. By F. J. PEARSON and R. R. OSBORNE. *Spon.* (37*s* 6*d*)

A Dictionary of Named Effects and Laws in Chemistry, Physics and Mathematics. By D. W. G. BALLENTYNE and L. E. Q. WALKER. 2nd Edition. *Chapman and Hall.* (30*s*)

Recent Advances in Soviet Science. *Todd Reference Books, London; distributed by George Harrap.* (25*s*)

There was a time in the history of England when the Prime Minister took a practical interest in science. The Marquis of Rockingham, who twice held that office, experimented with the production of oil from tar. However, in the late 18th and early 19th centuries, the English universities and so miscalled "cultured" opinion turned its back on science; technology was left to cranks, clever artisans and foreigners. Indeed, as we read the lives of eminent scientists of the last century, we find it was the chance of family circumstances which so often prevented them entering the then established professions and directed their talents to the sciences.

The expedient of war has led to much change. For strategic reasons, earlier in this century, such industries as the optical and chemical industries became firmly established in this country. More recently physicists were able to come to the country's aid with defensive and offensive radar systems and so on. Partly as a result of economic pressures we are at last beginning to appreciate how our peace-time industries must be scientifically based. But, even now, whilst for prestige reasons we would like to lead in every field, the "cranks, clever artisan and foreigners," mentality persists within branches of government. Within science itself one can still detect a distinction between "Pure" and "Applied." Yet is such a distinction logically possible in a scientificaliy based economy within the empiricism of all branches of science?

These thoughts offer a background against which it is possible to consider a diverse group of scientific books, all having something to do with physics yet written for very different readers. Pride of place is given to *A Physics Anthology* which is broader in scope than its title might suggest. It is a collection of lectures given at meetings of the Institute of Physics ranging from the philosophical to the educational through art and "pure and applied science." *The New Age in Physics*, by Professor H. S. W. Massey, achieves a successful non-technical presentation of the recent contributions of physics. Much of the present publicity received by physics comes from its contribution to the atomic industry. The solid background physics to this shows how doubtful is the traditional distinction between "pure" and "applied" science and the books look less glamorous than the more popular expositions. There is *Progress in Nuclear Physics Vol. 8*," edited by Professor O. R. Frisch, and a Russian contribution *Kinematics of Nuclear Reactions*, by Baldin, Gol'danskii and Rozenthal. *Practical Nucleonics*, by Pearson and Osborne presents a complete laboratory course in counting techniques which could also be of value to any laboratory beginning to use radioactive technique. Books like *A Dictionary of Named Effects and Laws*, by Ballentyne and Walker, are always fascinating to delve into and sometimes are really useful. However they usually have many shortcomings. This one, for example, mentions the Seebeck thermoelectric effect then gives a note on the Peltier effect but not the Thomson effect, the two which together constitute the Seebeck effect. Technically, a good scientific encyclopaedia would be more useful but also much more expensive. Lastly, but certainly not least in interest to the general reader, is *Recent Advances in Soviet Science*, which collects together a series of Russian Press releases ranging over the whole field of science and scientific education. The Russians certainly do not share our general national attitude towards the disinterested search for knowledge !

We are all familiar with the more spectacular scientific successes but Mr. Hasletts' foreword to *Recent Advances in Soviet Science* puts these in truer perspective. Russia too has its scientific heritage. Most know at least the names of Mendeleyev and Pavlov. There is direct continuity between Tsarist and Soviet science. A. F. Joffe began work on semi-conductors as early as 1901-02 and has, through the years, shown himself to be a great scientist and administrator. Within the scientific programme, the physical sciences still occupy a leading place with close support from the development of mathematics, computer and data processing methods. But the Soviet Union has been particularly a country of engineers first and foremost; then a country of prospectors for national resources. Speed in action has been the keynote and this atmosphere has been good for those physicists who were bold thinkers. It has not been so

good for the biological sciences where nature cannot be hurried. Surprisingly, too, the chemical industry was not an early priority, but now more attention is being paid to it and to the automation of all the process industries.

The medium of translated political press statements is not conducive to a pleasant literary style. Such phrases as the "search for a socialist style of architecture" immediately jar the reader in more ways than one. When reviewing educational policy we read of the preparation of pupils for "Socially useful work" and the strengthening of links between production and education—not in themselves bad things. Or again how the first year of certain advanced courses is by correspondence course while the student is at "work." "Work does a lot for the first-year student. He acquires habits of work and experience of life." Perhaps the book is at its most depressing when one reads the statement of the "Minister of Higher and Specialized Secondary Education" who seems to be striking an "attitude." Quite rightly he writes of the danger of isolation between the Institutes of Advanced Studies and Industry, but how it becomes bedevilled by scientific politics!

It is refreshing to turn from this to *A Physics Anthology*. Here there is a wealth of fascinating material. On education, Dr. Vick quotes Professor Du Bridge on "The essential role of colleges and universities as toughening of the mind, stimulators of curiosity. . . ." Dr. J. Thomson gave a lecture on "Educating Industrial Physicists" where he spoke of general agreement on the need to foster "creative technology." Time and time again lecturers stressed the unity of knowledge and were looking at the sphere of physics within it. The reader is warned that mathematics is but a tool and the danger that exists of losing the physical idea expressed in the shorthand of formulae. It is pointed out that few physicists, even, appreciate what Newton's laws of motion involve. Professor Dingle discussed the need to explore the development of scientific ideas and the danger of propagating wrong conclusions. Dr. Silver illustrates this in his lecture on "The Teaching of Thermodynamics."

Canon Raven spoke on "The Impact of Physics on Science and Religion" pressing the view that the whole intelligible world is the province of science, which is not just concerned with "gadget mongering"! The modern view of the world has led to a recovery of the sense of mystery and that now we can appreciate a greater sense of underlying unity; the need for a description of the progress of creation not just from its starting point but also from its goal "In terms not only of the atom or amoeba but of Christ and His Saints."

For solid amusement Professor R. V. Jones's contribution on "The Theory of Practical Joking: Its Relevance to Physics" is hard to better. It says much about the incongruous and the congruous and there are many anecdotes. Or again, for a change, there is the lecture by Mr. Rawlins on "Physics and Aesthetics." The volume ends with the record of a conference on "Ethics and the Scientist."

The Institute of Physics has certainly furthered the appreciation of physics by producing this *Anthology*. As Dr. Sillars said in another context "The big advances in material benefits seem generally to come as a bonus on the acquisition of knowledge" and this would be true for the community if those with responsibility yet little appreciation of science settled down and read this volume.

Progress in Nuclear Physics Vol. 8 begins with an article on the composition of primary cosmic rays. It is now known that these rays are predominantly protons and heavier nuclei, not, as earlier believed, electrons and photons. The situation now is very much in a state of flux but it is not expected that satellites will be such powerful research tools in this field. There is still much to be said for balloons! Other articles are concerned with the development of nuclear theory by analogy with a liquid drop; meson production; experimental techniques used in the study of Cherenkov radiation—an analogous electromagnetic phenomenon to the hydrodynamic shock wave produced by a body moving with greater velocity through a fluid than the local wave propagation velocity; the theoretical conclusions that can be drawn on the assumption that the effect cannot precede the cause; and the interaction of nucleons with a preponderance of spin in a given direction with nuclei. The publishers here have adopted the useful practice of listing the contents and contributors to previous volumes.

The volume on the *Kinematics of Nuclear Reactions* has been written to give a broad treatment of both classical and quantum mechanics of nuclear reactions. Again, it is intended generally for the research worker in nuclear physics.

Professor Massey's book on *The New Age in Physics* begins with a brief historical development of atomic physics, the wave and corpuscular nature of electrons, the uncertainty principle. Then he shows how this has been used in a chapter ("Mainly About Electrons") which reviews electron diffraction studies, thermionic valves and transistors, electronic computers, as well as the fascination of the approach to absolute zero. The development goes on to nuclear physics and its application to nuclear power and on—"Cosmic Rays and the Strange Particles." The other chief topics are concerned with radioastronomy, artificial satellites and space probes and their use. This is a lot of ground to cover within 350 pages, and junior students of physics and experts in other subjects together with the generally educated reader will be grateful to Sir Harrie for bringing so much of recent physics into perspective.

The right balance in teaching is difficult to find, and one sometimes has doubts about the number of people attending courses on nuclear technology, etc., who then go on to teach what they have learnt in other recently founded courses. In this, there is the danger of too much publicity for one branch of science. However, despite all of this, the value of nucleonic techniques is hard to overstress. They have application in most branches of science. *Practical Nucleonics* gives a sound course for physicists and for engineers. Besides the determination of a number of physical constants the 49 experiments detailed cover the operation of certain valve and transistor circuits, the use of electroscopes, Geiger counters, scintillation counters, nuclear emulsions, neutron detectors, the study of natural and induced radioactivity, and the calibration of sources.

In all of this the falsity of distinction between "pure and applied" becomes increasingly apparent. All knowledge, of a fundamentally descriptive nature or starkly applied, offers scope for increasing power within our environment and the challenge of responsibility for its use. The conference within the *Anthology* on "Ethics and the Scientist" brings out the dilemma of what to do. The encouragement is that "The big advances in material benefits seem generally to come as a bonus to the acquisition of knowledge." The challenge is that more than these are needed for our well being.

JOHN S. M. BOTTERILL

Trade Publications

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Plant and Equipment

Thickness Gauge. DAWE INSTRUMENTS LTD., Harlequin Avenue, Great West Road, Brentford, Middlesex. A leaflet describing the application and design features of a direct-reading ultrasonic thickness gauge. Illustrated.

Furnaces and Melting Pots. BARLOW-WHITNEY LTD., Coombe Road, Neasden, London NW10. A data sheet, giving particulars and sizes, of small electric furnaces and melting pots suitable for laboratories, research departments, technical colleges, tool rooms, and workshops. Illustrated.

Blockmaking Machine. WELDING INDUSTRIES LTD., Blackswarth Road, Bristol 5. Loose-leaf folder with particulars of handling, feeding, and casting equipment for the manufacture of building blocks. Blocks of 56 different varieties can be made with these mobile machines. 18 pp., illustrated.

Paging System. MODERN TELEPHONES (GREAT BRITAIN) LTD., Olding's Corner, Hatfield, Herts. A folder dealing with a radio paging system for locating personnel. The equipment transmits a distinctive call signal, followed by a spoken message. Illustrated.

Globe Valves. PERRETT CONTROL CO. LTD., Green Lane, Hounslow, Middlesex. A leaflet on the Hydrovalve, a remotely-controlled globe-type valve suitable for liquids and gases up to a line pressure of 125 lb per sq. in. Illustrated.

New Books

Introduction to Engineering Mechanics. By JOHN V. HUDDLESTON. *Addison-Wesley Publishing Company, Reading, Massachusetts, and London.* (74*s*)

A first-year university course in engineering mechanics, in which the emphasis is on fundamentals. The subject is divided on the basis of particles, rigid and deformable bodies, and energy and momentum concepts, as opposed to the traditional separation of statics and dynamics. Some knowledge of calculus and of elementary physics is presupposed, but general vector algebra (which is freely used) is developed in the first two sections.

Optical Microscope Technique. By D. BIRCHON. *Newnes.* (60*s*)

An exposition of the basic principles of microscopy is combined with a survey of modern specialized equipment and techniques. The approach is essentially practical, with the emphasis on techniques of observation.

Tables for the Compressible Flow of Dry Air. By E. L. HOUGHTON and A. E. BROCK. *Edward Arnold.* (12*s* 6*d*)

The parameters of isentropic, Prandtl-Meyer expansive, Rayleigh, Fanno, plane-normal and plane-oblique shock flows are tabulated for the Mach number range 0·01 (0·01) 4·00 and for $\gamma = 1{\cdot}403$. Descriptions of these six types of flow preface the tables.

Technical Reference Book of Compressed Air Terms and Standards. *British Compressed Air Society, 32 Victoria Street, London SW1.* (30*s*)

Addressed to both users and manufacturers of pneumatic equipment, this covers British practice in the installation, utilization and maintenance of compressors, rock drills, pneumatic tools, spraying plant, pneumatic control equipment and accessories. Upwards of fifty tables and graphs are included.

Gas and Air Compression Machinery. By LYMAN F. SCHEEL. *McGraw-Hill, New York and London.* (93*s*)

Written to serve as both a textbook and a design manual, this volume covers three areas of pneumatics: static and kinetic behaviour of gases; types of machinery used to displace gases, including reciprocating turbo, rotary and ejector types; and prime movers used for gas machinery, their installation, appurtenances, maintenance and operational details.

The Reviewers

Mr. B. J. Jeffery, B.Sc., A.M.I.Mech.E., is Principal Lecturer, in the Civil and Mechanical Engineering Department of the Woolwich Polytechnic.

Mr. A. Goldstein, B.Sc., A.C.G.I., D.I.C., M.I.C.E., M.I.Struct.E., M.I.H.E., M.Cons.E., is a partner in the firm of R. Travers Morgan and Partners, consulting engineers.

Mr. G. E. Tewson, M.A., is a partner in the firm of O. W. Roskill, Industrial Consultants.

Dr. J. S. M. Botterill, B.Sc., is a lecturer in the department of chemical engineering at the University of Birmingham. An Associate of the Institute of Physics and Member of the Society of Instrument Technology, his research interests are in dynamics and heat transfer properties of fluidized particle systems.

Marketing

Guy Motors Taken Over by Jaguar

JAGUAR CARS LIMITED who recently took over the DAIMLER COMPANY have established a further foothold in the commercial vehicle field with the acquisition of the business and physical assets of GUY MOTORS LIMITED.

Since the appointment of a receiver by Lloyds Bank Limited, the chief creditor in the firm's financial difficulties, orders have continued to be received at a steady rate and the purchase makes possible the continuance of the business, although it seems unlikely that sufficient money will be raised from the piecemeal sale of the assets to discharge the debt in full.

The winding up of Guy must come as a surprise to many people since some of the company's latest products had been well received and established a favourable reputation with fleet-owners. On the assumption that it be continued in its entirety the Guy range in addition to the very successful, rear-engined Daimler " Fleetline " passenger bus should provide Jaguar with a substantial commercial vehicle interest.

The Fleetline is to be exhibited at the Scottish Motor Exhibition taking place in the Kelvin Hall, Glasgow, between 10 and 18 November. Since its introduction at the Commercial Vehicle Show, Earls Court, 1961, orders worth more than £500,000 have been received and in this the first over-the-border venture, two will be displayed; one in show-chassis form and the other with a full front entrance 77 seater body by the NORTHERN COUNTIES MOTOR and ENGINEERING COMPANY of Wigan. Both will have the " Daimatic " semi-automatic gearbox giving two pedal control. The chassis will have the GARDNER 6LX 150 bhp diesel engine and the other, to be used for demonstration runs, will be powered by the Daimler 8·6 litre direct injection diesel engine mounted transversely at the rear.

Continuing their run of success in the private car field, the second day of the London Motor Show brought Jaguar orders from American and Canadian distributors worth $63 million (£22½ million). Ten thousand cars are involved—4,000 of the brand new Mark X's introduced just prior to the show, 4,000 of the E-type high performance Grand Touring cars and some 2,000 of the well established Mark II saloons.

This order doubles the Jaguar sales figures in North America this year and will stretch production capacity to its furthest extent. The Mark X contracts will take about three months to fulfil when the factory is running at the proposed target figure of 300 per week.

American Airline Buys BAC One-Elevens

The British Aircraft Corporation has received its first export order for its new BAC One-Eleven short-range jet airliner. The customer is Braniff International Airways of Dallas, Texas, who operate a number of inter-city services some of which are less than 250 miles. At present there is a firm order for six aircraft worth about £6¼ million with an option of a further six. Delivery is scheduled to commence in October, 1964, and continue through the first quarter of 1965.

Sir George Edwards, managing director of BAC, said: " This is the first time that a major American airline has ordered a foreign aircraft ' off the drawing board.' We welcome this indication of the confidence which Braniff feel that they can place in British Aircraft Corporation." He went on to report that exports to North America by BAC companies now totalled some £80 million and that there were high hopes of the One-Eleven taking this figure much higher. He did not think he was being over-optimistic in regarding this aircraft as potentially " another Viscount."

Thd One-Eleven is powered by two rear-mounted Rolls-Royce Spey Turbofan engines each developing about 10,000 lb thrust for take-off. It will seat 63 passengers and with a range of 1,000 miles allowing two hours fuel range, it has been designed to reconcile the passenger appeal of a rear-engine layout with better economics than existing short and medium range airliners.

Chloride Batteries and the Export Market

Speaking at the Annual Motor Show Press Luncheon arranged by CHLORIDE BATTERIES LIMITED, the Chairman, Mr. A. W. Browne, stressed the importance of the export market to the group's activities, whether it be in the form of direct sales, or indirectly by way of cars fitted with Exide batteries.

Exports had increased over the last year but, during the last decade, there had been a movement of manufacture away from the U.K. and the Group now has companies manufacturing Exide or Chloride batteries in eleven countries overseas where tariffs and other restrictions make exporting impossible.

However there were still countries in which it was impracticable to sell direct or manufacture locally leaving the operation of " know-how " agreements with licensees as the only course open.

Mr. Browne went on to say that a long established reputation for quality was insufficient to maintain exports in the face of the intense competition encountered at the present time. It must be allied to continuous research, modern design and improved production techniques, all of which must be supported by virile salesmanship. He believed that these reasons had been contributory factors to the position in some countries, where, being unable to export complete batteries, the Group was still able to sell components for inclusion in locally built products. Notable amongst these were Porvic separators, developed and produced exclusively by Chloride.

New Office for AEI Sales Divisions

To cope with the need for more space in the light of increased business and a larger sales staff, ALLIED IRONFOUNDERS LIMITED have erected a new building on a 17½ acre site in Cadbury Road, Sunbury-on-Thames, Middlesex. The move in was effected on 25 September when three sales divisions; the domestic appliance division, the bath division and the electrical appliance division were transferred from offices previously occupied in Dering Street and Orchard Street, London.

The new accommodation has been specially designed to the requirements of a sales division and complies with the Government's policy of encouraging the movement of industry outside the Metropolis. Three storeys high, it will house in addition to the sales staff, the literature mailing department and the Powers-Samas sales-analysis department. It has a conference room, a staff dining room and a kitchen specially designed and fitted out by the company's catering equipment division.

The Group's main London headquarters and showroom remain at 28, Brook Street; and while the offices in Orchard House have been given up, those in Dering Street will continue to house the catering equipment and export division for which increased accommodation will now be available.

Sales of Domestic Appliances

The accompanying table indicates the figures for the sales of new appliances as supplied by the area Electricity Boards in England and Wales for the month of August and the 12 months up to that time. Percentage variations over the corresponding periods for the previous year are also shown.

Apart from cookers and immersion heaters, the sales of which have remained fairly steady, there has been a marked decline over the past year especially in the sale of washing machines. This has no doubt been largely due to finance and credit restrictions and the necessity for larger down-payments. However during August the decline was halted and there was a slight improvement in washing machine figures and a fairly substantial increase in those for refrigerators. There appears to be every indication of an upward trend.

Wash boilers sales continued to fall, the most probable reason here being the coming obsolescence of this type of equipment with the introduction of the more sophisticated types of washing machine now available. Electric clothes dryers, which have never really been popular, showed the biggest drop of all in August possibly because their use is somewhat seasonal.

These figures show only the sales by the area boards and therefore represent a substantial proportion, though not all of total sales throughout the country. The business transacted by private concerns would probably affect the actual figures but should support the reflected trends.

	Sales in month ended 31 August, 1961		Sales in 12 months ended 31 August, 1961	
	Total	per cent change over corresponding period of previous year	Total	per cent change over corresponding period of previous year
Cookers	26,944	+ 2·0	352,231	+ 3·9
Water Heaters:—				
Immersion	16,941	+ 1·8	194,670	+ 2·2
Storage	4,440	− 14·2	62,787	− 7·1
Wash Boilers	4,207	− 7·3	54,079	− 9·7
Washing Machines	7,943	+ 2·1	104,482	− 21·9
Refrigerators	10,318	+ 12·7	141,018	− 3·9
Clothes Dryers	1,676	− 40·8	52,741	NA

Mechanized Plant for Australia

One of the largest mechanized structural steel plants produced so far by BOULTON AND PAUL LIMITED has just reached completion at their Norwich, Norfolk works. The first of its kind manufactured by the company for the Australian market, the new plant will be installed at the South Melbourne works of JOHNS AND WAYGOOD, a leading Australian structural engineering concern. It has been specially designed to the customers' requirements at a cost of £100,000 and will occupy 21,000 sq. ft of floor space. Its function is to cut bars to length in a vertical saw, and drill all necessary holes by means of a series of vertical and horizontal drilling machines. All are connected by a system of powered conveyors and transfer benches controlled from three push-button stations. The plant is said to be capable of handling, sawing and drilling steel sections up to 36½ in wide and 50 ft long more expeditiously than hitherto possible by conventional methods with a resulting increase in production and economy. The equipment will be shipped in the form of crated components and, after erection under Boulton and Paul supervision, is scheduled to commence operation towards the end of the year.

This is the thirteenth mechanized plant to be built by the eompany since 1955 when, following three years development of a prototype, it was decided to manufacture for sale throughout the world. Incorporated in the equipment are drilling machines manufactured by JAMES ARCHDALE LIMITED of Worcester, vertical saws from CLIFTON AND BAIRD LIMITED of Glasgow and the electric motors and switchgear of LAURENCE, SCOTT AND ELECTROMOTORS LIMITED of Norwich.

CEGB Order for Gwynnes Pumps

The CENTRAL ELECTRICITY GENERATING BOARD has placed an order valued at approximately £325,000 with GWYNNES PUMPS LIMITED for circulating water pumping equipment at the new West Burton Power Station.

The contract covers the supply and installation of eight 78 in by 80 in horizontal, double-entry, split-casing centrifugal pumps, each with a capacity of 130,000 gallons per minute against a total head of 70 ft, running at approximately 265 rpm. Drive will come from ENGLISH ELECTRIC 3,350 bhp squirrel-cage motors running at 990 rpm through Allen-Stoekicht epicyclic gear units which will be built at the Pershore, Worcester works of W. H. ALLEN AND COMPANY LIMITED of Bedford, the parent company of Gwynnes Pumps.

The Froude G4 Hydraulic Dynamometer

No one, not even a company engaged in a specialist and conservative industry, can afford to ignore the quickening tempo of technological advancement.

THINK of any machine—and the chances are thousands to one that you will conjure up in your mind's eye a device intended to create, transform, transmit or utilize power in one form or another.

Alone among mechanical devices the dynamometer does none of these things. Its function is to *absorb* the power developed by an engine—with the object of measuring accurately the brake horse-power over the working range of engine torque and speed.

In actual fact, an absorption dynamometer, such as the Froude, converts the whole of the incoming energy into heat. This fact may be readily checked by measuring the amount of water passing through the dynamometer together with its inlet and outlet temperatures. The result will correspond closely with Joule's mechanical equivalent of heat.

At first sight it might be imagined that in order to absorb the power generated by a prime mover, a device such as a dynamometer must be roughly equal to it in size. Actually the dynamometer can generally be made smaller than the prime mover, and the disparity in size increases markedly with increase in size of engine and quantity of power to be absorbed, as Fig. 1 shows.

While it would be possible to use a similarly sized engine as a dynamometer, arranged in opposition—it has been done for railway locomotive road testing by rigging up a "counter pressure" locomotive to simulate the trailing load—such a procedure would be most uneconomical in normal practice. The size of a hydraulic dynamometer varies according to the following law: brake horsepower is proportional to $D^5 N^3$ where D represents the peripheral diameter of the rotating element and N the speed.

The most obvious phenomenon to employ in order to dissipate energy is friction. The simplest and one of the oldest forms of dynamometer uses the principle of the band brake, but its power absorption rate is severely limited by the amount of heat liberated. When, in 1877, the Admiralty assigned William Froude, F.R.S., the task of devising some means of establishing precisely the horse-power required to propel ships, his thoughts were directed towards something that could be attached to the shaft with the ship in dry-dock. The result was the hydraulic dynamometer arranged as in Fig. 2, in place of the propeller.

Due possibly to a natural inclination as a naval architect to use water as the operative medium, in the hydraulic dynamometer Froude hit upon a machine with overwhelming advantages over the friction type. The basic operating principles he established are manifest in hydraulic dynamometers today, including the G4, the subject of this article. The hydraulic dynamometer, invented originally to measure ships' shaft horsepower, still owes its current development in the largest sizes to marine application. The machine in Fig. 1 is being used to measure the torque developed by a 21,000 bhp marine diesel engine.

OPERATING PRINCIPLES

The hydraulic dynamometer absorbs power by inducing a change in mass momentum of water circulating between the casing and rotor. It is inherently compact and, since it possesses virtually no power absorption rate ceiling, it can be built in large size. Furthermore the entrained water itself acts as a coolant, and heat removal entails nothing more than providing a relatively small flow of cold water through the casing. Only under exceptional circumstances is any fluid other than water seriously considered.

Heenan and Froude have so far produced hydraulic dynamometers for duties varying between 50 and 60,000 bhp, and this range could be extended in either direction. They are in everyday use for testing virtually any kind of engine from small motorcycle engines to the largest marine diesels. Naturally, the trend towards standardization is more noticeable at the lower end of the scale, between 50 and 5,000 bhp at about 1,000 to 10,000 rpm. The G4 represents a new dynamometer concept and was introduced five years ago; it can absorb powers up to 350 bhp at 2,000 to 6,000 rpm. In order to appreciate its finer points, it is first of all necessary to study Froude's basic operating principles.

Referring to Fig. 5, the engine shaft is coupled to the dynamometer shaft which carries a rotor having on each side a series of semi-elliptical cups separated by vanes. The rotor runs between similar cups, also separated by vanes, formed in the casing liners. Thrower rings or shaft glands keep the casing halves water-tight.

Rotation of the rotor shaft causes the water in the casing to circulate by centrifugal force round the elliptical orbit formed by each rotor cup and its opposite casing cup, thus absorbing the power reaching the rotor from the engine. The casing is carried on trunnion bearings in such a way that it can respond freely to the torque being absorbed. It is only prevented from being carried round with the rotor by being connected to the system of levers and weights comprising the torque weighing gear. A little power is also absorbed by the glands and the shaft bearings, but as they are mounted in the casing the power loss from this source is included in the total reaching the torque weighing gear.

A minimum guaranteed accuracy of 0·25 per cent or less is commonplace to Heenan and Froude. Despite many attempts to increase power absorption by reshaping the rotor, the relationship Froude established between the peripheral diameter and cup dimensions has not been bettered, and is generally accepted as standard for all hydraulic dynamometers.

The load which the dynamometer imposes on the prime mover can be regulated in two ways: (1) by means of William Froude's "sluice gate" control, wherein a pair of blanking plates can be progressively inserted between the rotor and casing cups or

(2) by regulating the amount of water present in the casing, thus varying the thickness of the vortex film of water circulating within the rotor and casing cups, as in the G4.

Many dynamometers are still supplied with sluice gate control, but the attendant disadvantages of bulk and large internal areas subject to erosion, calling for special materials, plus the effort required to move the gates, all combine to restrict the sluice gate to smaller machines.

Varying the water film thickness was first devised in 1910 by Professor Osborne Reynolds, the well known hydrodynamicist. Heenan and Froude employ two systems, the more recent of which was introduced in the G4. The older method of back pressure control depends upon a casing water outlet valve with its setting under the precise control of a positive oil pump driven from the dynamometer shaft. It has practical limitations in smaller machines.

The G4's system is a direct alternative to sluice gate control and may eventually displace it. A centrifugal pump attached to the rotor shaft (which itself absorbs a proportion of the power) draws water from a sump at the base of the machine and feeds it to a control valve at the casing inlet. There is no valve on the downstream side, discharge taking place through a fixed orifice.

The G4 was evolved to meet a growing need for a new machine. Its neat, almost streamlined appearance is largely due to Mr. F. James Fielding, managing director of the Heenan group, who felt that the advanced technical design should be reflected in its appearance. A number of design problems had to be overcome, which led indirectly to the idea of replacing the conventional bedplate by an integral chassis.

The chief technical improvements in the G4 can be summarized as follows:

(1) Small size and compactness in relation to

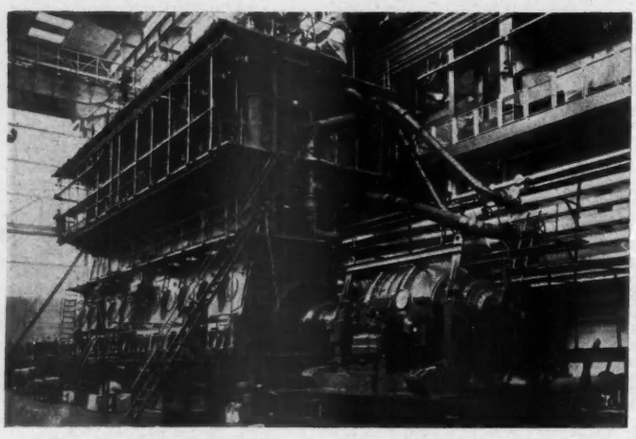


Fig. 1 (left) Froude 30,000 hp dynamometer testing a marine engine.

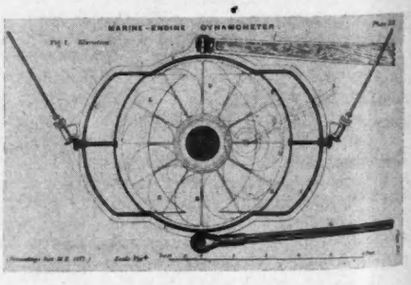


Fig. 2 (right) Diagram from William Froude's original paper to the Institution of Mechanical Engineers in 1877, showing his sluice gate controlled dynamometer for fitting to a ship's propeller shaft.

Fig. 3 A graceful and functional appearance is becoming increasingly important to unexpected kinds of engineering product.

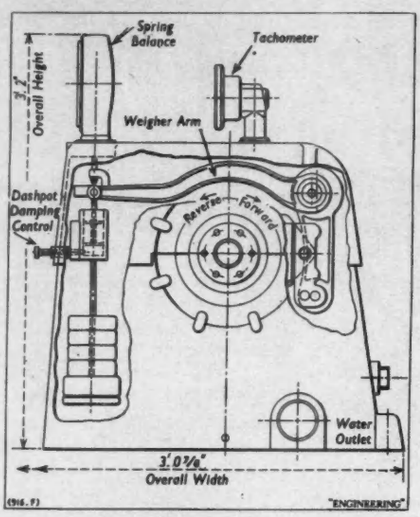


Fig. 4 (above) End view of G4 cut away to show torque weighing gear.

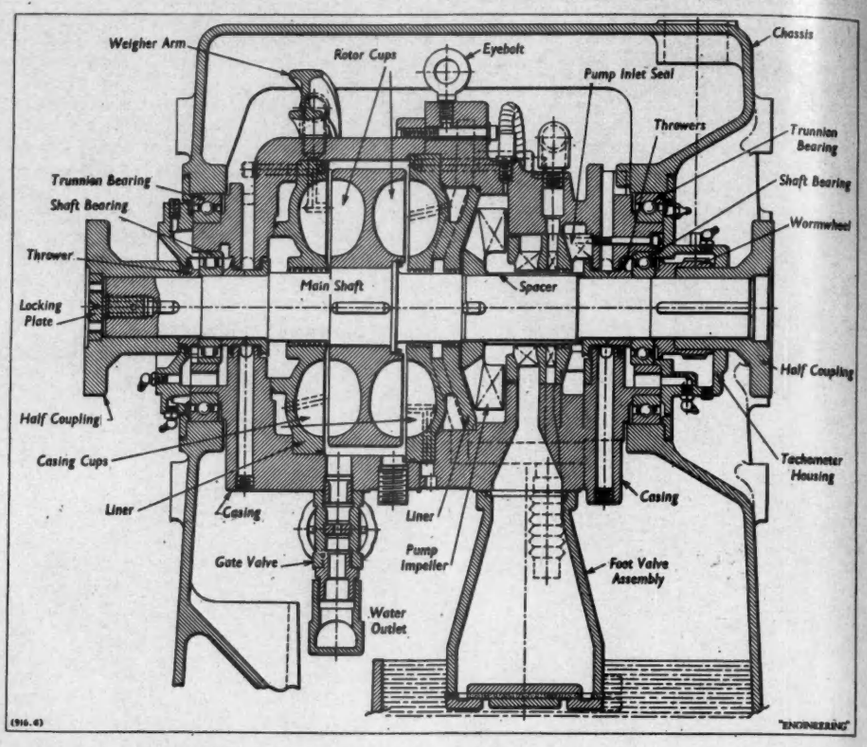


Fig. 5 (right) Axial cross-section of the G4.

Fig. 6 (below) The DPX-4 with sluice gate control.

its duty, due to the elimination of shaft sealing glands and sluice gates.

(2) Convenience of operation due to the grouped controls and measuring elements, and having no weight heavier than 5 lb to be handled.

(3) Stability of running inherent in the new control system.

(4) Low maintenance requirement.

Additionally, it maintains its creators' established standard of accuracy, long life, and, equally important, low cost. For eliminating the sluice gates enables both rotor and casing to be produced in spheroidal cast iron instead of using aluminium-bronze castings.

Another improvement in the G4 is emphasized in the performance curve, Fig. 7. The pump impeller is so sized that it does not cease work at the lowest powers, thus giving the G4 an exceptionally wide range of performance.

A dynamometer is basically a undirectional machine, and while the larger sizes sometimes have two rotors to provide reversibility, the smaller units have two coupling flanges on the rotor shaft so that either end can be coupled to the engine. In the G4 this provision is less necessary since it is capable of absorbing about 50 per cent of full power in reverse.

The G4 corresponds in duty with Froude's DPX-4 sluice gate machine, rendering it particularly suitable for testing road vehicle engines, but it is far more compact and also less expensive. In the not-too-distant future the range of the G type will be increased both ways by the introduction of G3 and G5 machines.

Load control is by means of a handwheel on the front panel together with a handle for testing governed engines so that the load may be removed and returned instantly to the same setting. Ordinary town mains water supply and pressure are usually sufficient for satisfactory operation. Test weights are supplied for torque calibration, and a friction brake to give extra capacity at low speeds may be fitted if required.

Though Heenan and Froude Limited use the name Froude as the trade name for hydraulic dynamometers, William Froude never had any direct connection with the firm. It was his son, Richard Froude, who entered into an engineering business partnership with Hammersley Heenan in 1881, bringing with him his father's patents and the manufacturing rights of the hydraulic dynamometer. Since then the company have turned out a variety of equipment (including Blackpool Tower), of which the hydraulic dynamometer has played a consistently important part.

Other important products today are refuse disposal plants, evaporating water coolers, air coolers, wire and strip forming machines, and eddy-current couplings and dynamometers. The last-mentioned machines contain a rotor carrying several poles, which rotates inside a stator casing, thus generating eddy currents tending to oppose rotation. The excitation current is regulated electronically, so the eddy-current dynamometer lends itself to programme control. By comparison, the hydraulic type is simpler and cheaper and considerably more compact for bigger duties.

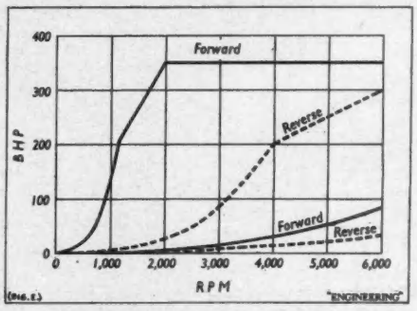


Fig. 7 Performance curve for the G4.

SELLING POLICY

In common with many successful companies which have been treated in Product Profile, Heenan and Froude market the function, rather than just the product. Their dynamometer sales executives are all trained engineers. A dynamometer contract may include a complete test bed comprising engine cradle(s), dynamometer(s), cardan shaft(s) for engine coupling, fuel system with flow measuring facilities, engine and dynamometer cooling system, control and instrument panel and exhaust disposal system—apart from the building itself.

During the war the company supplied 98 per cent of the aircraft engine test equipment, and a notable postwar job was the Rugby Locomotive Testing Station of British Railways, now, regrettably, closed. Exports form a prominent side of the business as the metric/English measuring facilities of the G4 bear witness, and dynamometers go behind the Iron Curtain.

Perhaps the biggest embarrassment to the company is the tremendous variety of standard and custom built dynamometers they produce—a variety necessary if they are to remain foremost in the dynamometer field, and a successful deterrent to any other British company to offer serious competition. Spare parts may be required for machines 60 years old and more, and no less than 170,000 dynamometer drawings have been microfilmed and are stored in duplicate in different parts of Worcester.

Heenan and Froude may be regarded as the parent company of a group comprising eight firms having a wide diversity of interests and a total capital of £2m. Good relationship between management, workers and trade unions; a planned apprentice intake based on anticipated requirements 20 years hence; promotion from within whenever possible; assistance with housing for key personnel; such policies tend to foster the harmonious atmosphere that helps to spell " success " in an increasingly competitive world.

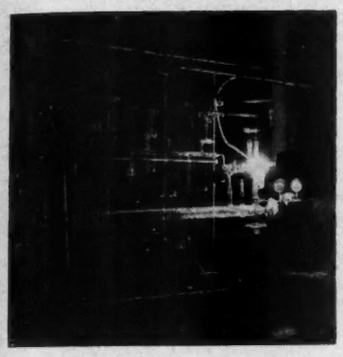
Heenan and Froude Limited, Worcester.

Plasma Studies on Chemical Systems

The white hot glow seen in the accompanying illustration comes from a low-temperature, high-density plasma being used with spectroscopic equipment at the laboratory of the Battelle Memorial Institute to study the effect of the plasma's intense heat on chemical systems.

Despite its classification as " low-temperature," the plasma operates at an estimated temperature of 6,000° C. In plasma physics, temperatures in the range of 5,000° C to 15,000° C are considered to be low. In this temperature range, the nature of many chemical compounds is considerably altered but ionization is not severe.

Dr. G. G. Mannella, who is supervising the studies with the plasma apparatus, says that this work is quite fundamental and that he foresees the possibility of plasmas eventually being used on a commercial scale to promote chemical reactions that have not previously been feasible. Such reactions might well lead to materials with unusual high-temperature properties.



A low-temperature, high-density plasma is being used to study the effects of intense heat on chemical systems.

Chemical systems to be studied at the Columbus, Ohio, research centre of the Battelle Institute include simple inorganic biradicals, such as nitrogen, hydrogen, oxygen and nitric oxide, and possibly such organics as methane and benzene. Preliminary work on nitrogen plasmas shows the unit to be extremely efficient in dissociating nitrogen into atoms.

Quick Drying for Sewage Sludge

Disposal of the sludge which is removed during sedimentation of sewage has long presented a difficult problem, since large areas of drying beds are required. The same problem is now being experienced at a number of factories, especially in cases where land is difficult to obtain.

For this reason, the Water Pollution Research Laboratory of the DSIR is investigating the factors which affect the rate of drying of sludge on beds, with the object of speeding up the process.

Pilot scale beds have been constructed in such a way that the drainage liquor can be collected and measured. Beds which can be weighed are also being used so that the water lost by evaporation can be determined.

Some of the factors being studied are the effects of coagulants and of the depth of the layer of sludge applied to the beds. A quantitative method for measuring the ease with which a sludge can be dewatered has been improved at the Laboratory and has been used to measure the " drainability " of sludges from different works; very large differences have been found.

A surprising finding has been that primary digestion often makes the sludge more difficult to dewater, and, although secondary digestion may improve drainability, serious difficulties are sometimes encountered in disposal of the digested sludge.

It seems that excessive pumping of the digesting sludge through heating units may be a cause of trouble; experiments are now being made at one sewage works to pump the sludge by means of a gas-lift pump, which should shear the sludge flocs to a much lesser extent than the vertical axial flow pumps initially fitted to these plants, and should also require less maintenance.

New Material for Microwave Engineering

A significant advance has been reported in the understanding of yttrium iron garnet (YIG), a material that provides a substantial improvement over ferrites in many electronic applications.

YIG is similar to the ferrites in that it is both ferrimagnetic and an electrical insulator, but it has a different crystal structure which makes it a much improved insulator. Both types of material transmit microwave radiation with very little loss. Equally important, when a strong dc magnetic field is applied to them, they can be made to transmit microwaves in one direction with l tle loss, but strongly absorb radiation in the reverse direction. This makes them useful as " isolators," or one-way transmission lines. Other uses for these materials include tunable filters and power limiters for microwave systems. The results reported are of particular importance in such microwave applications.

One of the primary techniques used in studies of these ferrimagnetic insulators is measurement of the " ferromagnetic resonance linewidth." When a dc magnetic field and a small radio frequency magnetic field are applied to a specimen, a resonance peak occurs where the rf energy is strongly absorbed. The width of this resonance peak for a constant applied rf magnetic field is a measure of the lossiness of the material.

In a paper read at the International Conference on Magnetism and Crystallography, held in Kyoto, Japan, Drs. R. C. LeCraw and E. G. Spencer, both of Bell Telephone Laboratories, USA, reported ferromagnetic resonance linewidths of only 0·14 oersteds at room temperature and 6,000 megacycles in YIG—the narrowest linewidth ever reported for a ferrimagnetic material. This is many times narrower than the linewidths reported for the best ferrites, which are of the order of 5 oersteds.

This rema kably low linewid'h was ob'ained by polishing he c ys als to an ext' emely smoo h finish and by emoving impurities by me hods e pecially developed for the pu pose. It is believed that the residual linewidth at low tempe a u es is caused by the p esence of fe rous ions. The measu ed wid'h now ag ees closely wi h a ecen ly developed theo.y, except at very low tempe a.ures.

Fresh Evidence for Rainmaking Theory

Australian research into techniques for precipitating rain, carried out by the Commonwealth Scientific and Industrial Research Organisation, has recently revealed new evidence on the possible origin of freezing nuclei. The presence of these nuclei is known to be vital to the formation of rain from a supercooled cloud but, so far, they have not been identified.

The new light which has been thrown on to the subject resulted from a study of samples collected at high altitudes by U-2 aircraft operated by the US Air Force from a base in Victoria. Special dust collecting filters were fitted to the aircraft and samples of freezing nuclei were obtained from ocean areas well to the south of Australia. The filters were installed in pairs, but only one of them was exposed to the airstream when the aircraft reached the desired height; the unexposed filter acting as a control.

The results show unmistakably that substantial numbers of freezing nuclei occur at these high altitudes—very many more than can be accounted for if they all come from the Earth's surface. Support is thus given to a theory advanced by Dr. E. G. Bowen in 1953 that a powerful source of freezing nuclei is the meteor dust which the Earth picks up as it intersects the orbits of various well known streams of meteors. This meteoric dust takes some thirty days to sink to the cloud bearing levels of the atmosphere, whereupon, if meteorological conditions are favourable, it stimulates heavy rainfall.

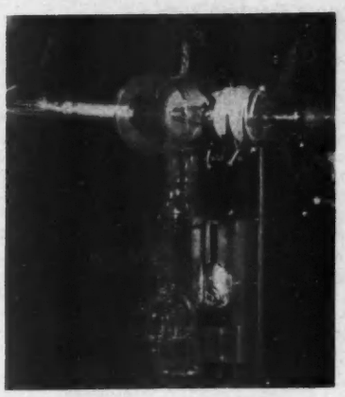
Samples of the dust present at high altitudes were also collected and submitted to various tests in order to determine its nature, and hence its origin. The quantities available proved too small for definitive analysis, however, but the results obtained are consistent with the theory of extraterrestrial origin.

Study Technique for Catalysis and Corrosion

Some of the first results of a new technique foe studying surface reactions were described at thr International Conference on Magnetism and Crystallography, recently held in Kyoto, Japan.

Inventor of the technique, Dr. L. H. Germer, and co-research worker Dr. A. U. MacRae, both of Bell Telephone Laboratories, New Jersey, USA, reported on studies of adsorption of monolayers of gases on a crystal surface, using the new method.

In their apparatus (shown in the accompanying illustration) low energy electrons are diffracted



A new technique, in which low energy electrons can be diffracted at a surface and accelerated to a fluorescent screen, is being used to study surface reactions.

from a surface and accelerated to a fluorescent screen by a strong electric field. The diffraction pattern produced on the screen gives the arrangement of the first monolayer of atoms on the surface.

The technique is providing a powerful tool for the study of surface reactions, since it gives a detailed picture of the arrangemeut of atoms entering into such reactions. It is opening the way to a far closer understanding of such surface phenomena as catalysis and corrosion. As a result of such understanding, according to Dr. Germer, " catalytic chemistry will be a different kind of science and very probably revolutionary advances will be made in it."

In their paper at the Kyoto conference, Drs. Germer and MacRae reported on studies of oxygen and hydrogen adsorption on a nickel crystal. They found that after a monolayer of oxygen had been adsorbed, nickel atoms diffused to the surface producing an orderly arrangement containing either one or two oxygen atoms for each nickel atom. The arrangement containing equal numbers of oxygen and nickel atoms proved to be remarkably stable, persisting up to temperatures at which nickel evaporates rapidly. The Bell team found, however, that the oxygen can be easily removed by hydrogen at moderate temperatures and that, in turn, the hydrogen can be removed by slight heating, leaving a perfectly clean surface.

Testing Greases for Nuclear Reactors

Research engineers of Esso Research Limited have recently designed and built a rig for determining the performance of bearing greases in carbon dioxide atmospheres.

By D. F. G. Hampson, A.M.I.Mech.E., and R. Tourret, M.Sc.(Eng.), A.M.I.Mech.E., A.F.R.Ae.S., F.Inst.Pet.

GREASES intended for use in the hot zones of present designs of British nuclear power stations must be capable of withstanding a combination of radiation, heat and carbon dioxide for long periods. Under these conditions, they must not change in consistency or drop point, nor give evaporation loss. Further, they must not exhibit any undesirable properties when in contact with the Magnox alloy used for fuel cans and, finally, they must lubricate bearings when in contact with a hot atmosphere of carbon dioxide.

All but the last item—mechanical performance in a bearing surrounded by a carbon dioxide atmosphere—can be determined by conventional chemical and physical tests, but this final item requires specially-designed equipment. Such equipment has been developed and is now in use at the Abingdon Laboratory of Esso Research Limited.

English Electric Rig

Originally, work was carried out on a rig similar to one designed for testing nuclear greases by the English Electric Company Limited. Their work in this area was described recently,[1] but no details of this particular rig were given.

As operated at Abingdon, (Fig. 1) it consists of a $\frac{5}{8}$ in by $1\frac{1}{16}$ in by $\frac{1}{16}$ in angular contact ball bearing lightly loaded axially (100 lb) and driven directly by an electric motor at 1,420 rpm. The test bearing can be heated up to 200° C and at the same time carbon dioxide is gently blown through at about 100 cu. cm per min. The bearings used in service are generally protected by "Nylos" seals. These are also used in the rig, but to increase the severity of the conditions, small holes are drilled in the seals to allow the carbon dioxide to contact the grease readily and to allow any oil or liquefied grease to escape.

To increase the severity of the test further, the test bearing has a bronze cage instead of steel; this increases the tendency of the grease to break down chemically. Usually, greases are irradiated and then given either a screening test for 100 hours, or the standard test of 1,000 hours. At the end of the test, the bearing must be in good condition, with no escape of grease or oil.

This rig has provided useful tests for some years but might be considered limited for three reasons: (1) the carbon dioxide is not pressurized, (2) temperatures are limited to 200° C maximum, and (3) the frictional torque of the grease in the test bearing cannot be measured. Furthermore, the bearing speed is higher than in practice.

Closer Simulation

Experience with other bearing rigs suggested that considerable development work would be involved if a completely new test rig was designed. For example, the Institute of Petroleum grease rig required years of cooperative work by many laboratories before a method was published.[2]

It was decided to take a proven existing test rig and modify it to meet the following requirements:

(1) Sufficient load on the bearing(s) to prevent skidding.
(2) Temperatures over 250° C.
(3) Carbon dioxide at 200 lb per sq. in pressure and flow of 10 ± 5 litres per hour.
(4) An indication of the friction torque.
(5) Speed of 100 ± 5 rpm.

The most suitable equipment was the American Society for Testing Materials' wheel bearing rig, which has been operated for years in many laboratories and has proved to be very reliable. In this rig, two taper-roller bearings on a test shaft are loaded against each other by a nut and torque wrench, to give a very compact loading system. The whole rig is already in a heat-insulated cabinet. Thus the standard rig meets condition (1) and goes a long way to meeting condition (2). To meet the other requirements above, several modifications had to be made Fig. 2 shows the engineering details of the rig which was finally developed while Fig. 3 shows an external view.

In the first case, the bearings used in nuclear power stations are chiefly ordinary ball bearings, whereas the standard rig uses taper-roller bearings. Ordinary ball bearings, especially of the deep-groove variety, will accept a slight axial load, however, so these were substituted. Two different sizes were chosen, 35 by 72 by 17 mm and 20 by 47 by 14 mm. The axial dimensions are such that when the nuts are tightened up (to a stop), adequate load is applied. The shaft and the housing separating the two bearings were both of steel, to minimize differential expansion effects on the loading.

Secondly, to maintain the CO_2 pressure (condition 3), the chamber holding the bearings had to be sealed, while keeping friction to a minimum to enable torque to be measured (condition 4). Carbon-ring bellows seals proved suitable.

The centre shaft was drilled axially and at

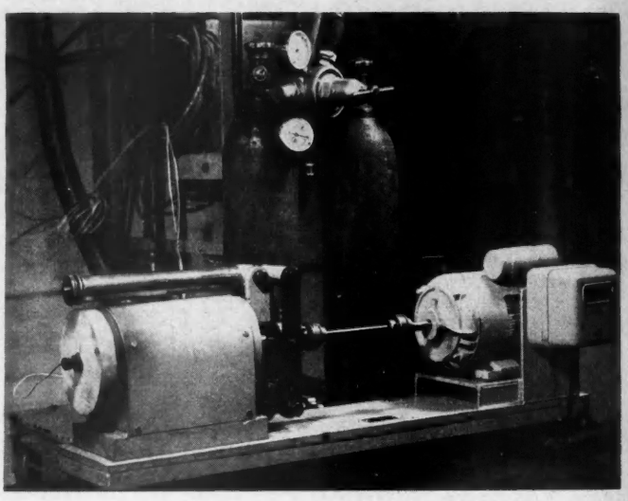
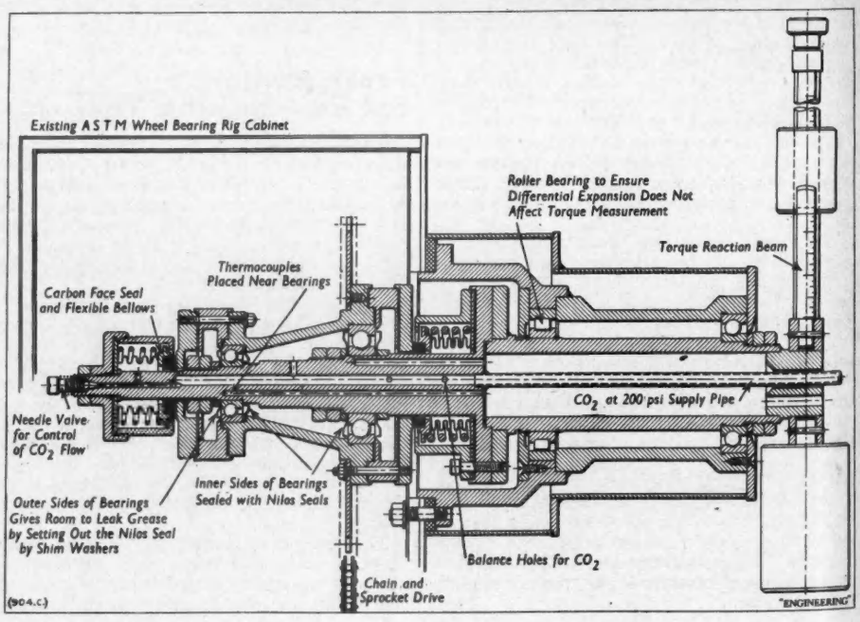


Fig. 1 (right) Grease test rig designed by the English Electric Company.

Fig. 2 (below) Rig designed by the American Society for Testing Materials, after modification.


Existing A S T M Wheel Bearing Rig Cabinet
Roller Bearing to Ensure Differential Expansion Does Not Affect Torque Measurement
Torque Reaction Beam
Thermocouples Placed Near Bearings
Carbon Face Seal and Flexible Bellows
CO_2 at 200 psi Supply Pipe
Needle Valve for Control of CO_2 Flow
Inner Sides of Bearings Sealed with Nilos Seals
Outer Sides of Bearings Gives Room to Leak Grease by Setting Out the Nilos Seal by Shim Washers
Balance Holes for CO_2
Chain and Sprocket Drive
(904.c)
"ENGINEERING"

Research Report

on work of

Esso Research Limited, Abingdon, Berkshire.

Research Team

D. F. G. HAMPSON, A.M.I.Mech.E.

R. TOURRET, M.Sc. (Eng.), A.M.I.Mech.E., A.F.R.Ae.S., F.Inst.Pet.

several radial points to enable carbon dioxide to be fed directly to both sides of both test bearings; Nylos seals were fitted. To enable the carbon dioxide to contact the test grease, the seals were given clearance on one side of each test bearing by fitting a shim. Any oil or liquefied grease could then escape, and thus grease deterioration be noted. If for any reason less severe conditions of actual service were to be simulated, the shims were placed outside the seals so that they pressed directly against the bearings and completely sealed them. The centre shaft was also drilled to take thermocouples to each bearing. To allow carbon dioxide to be bled off at the required rate, a small needle valve was placed at the end of the test shaft.

In this rig, the outer races of the bearings rotate, rather than the inner. This generally presents a more difficult lubrication problem.

Thirdly, to give some indication of frictional torque (4), the whole test shaft was not fixed rigidly to the back of the casing as in the standard rig, but was taken through the back of the casing and mounted on two slave bearings. It could rotate freely, but was restrained by stops on a weighing lever at the back. An indication of the friction could thus be obtained.

On reducing the motor speed by a simple gearbox to meet requirement (5) it was found

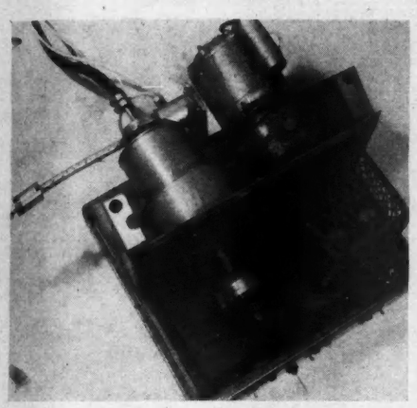


Fig. 3 The modified ASTM rig.

that the spring belt slipped, and the pulleys and belt were replaced by sprockets and chain.

Initial tests were carried out using the existing electrical heaters but, as expected, these had to be up-rated to meet the higher heat requirements. Both heaters were controlled by a 2 kVA Variac, while a West Guardsman controller was used as an indicator and as a high temperature cut-out. The control couple was in air near the top of the insulated box. It takes one hour for the box to reach the required running temperature, and approximately four hours for the bearing temperature to stabilize after which there is a 12° C temperature differential between the two bearings containing the test grease.

The rig has been found to perform very well in practice. The torque-measuring device is not particularly sensitive, but it was realized in the design stage that the slight friction from the contact-type carbon-ring seals would preclude precise torque measurements.

Acknowledgements

The authors wish to express their thanks to the directors of Esso Research Limited for permission to publish this article, to the English Electric Company Limited who allowed their design to be adopted for the original work at Abingdon, and to Spares and Equipment Limited, Hill Street, Kingswood, Bristol, who cooperated in the redesign of the ASTM rig.

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[1] Heath, H. H., "Bearing Wear in Corrosive Atmospheres." *Engineering* vol. 189, no. 4913 (17 June, 1960), p. 841.

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Theory for Cylindrical Pressure Vessels

In a power plant operating at high temperatures and pressures, the working conditions are frequently such that, during the life of the pressure vessels and tubes, both creep and elastic strain in them will be important. In general, however, the design of such cylindrical pressure vessels and thick walled tubes has been based either on considerations of creep strain only or, in some cases, of elastic strain only. In either case the other factor, which may often be important, is ignored.

It is clearly desirable to be able to take account of both creep and elastic strains when they are of comparable magnitude. An analysis, based on the transition from pure elastic to virtually pure creep conditions, which occurs in service, would represent a large number of practical cases more correctly than existing methods.

A theoretical relation has therefore been derived at the National Engineering Laboratory, East Kilbride, to relate stress, strain rate, and time with position along the radius and axis of the vessel or tube. This has been based on creep-strain/time relations for a variety of engineering materials under complex stresses, which have been obtained experimentally at the laboratory over a number of years.

This theory has been applied to estimate the values of principal stresses and strain rates in tubes for representative cases of six materials at temperatures within their practical working range. In particular, these predictions have been compared with those obtained from elastic theory, and from the pure creep theory of Bailey which has been much used in practice. The comparison indicates that, for the materials investigated, neither elastic theory nor pure creep theory adequately represents the changing stress distributions and strain rates that occur; although after considerable periods of time, upon completion of stress distribution, values based on the Bailey pure creep theory would not be seriously in error.

A complete example of the applications of this general theory has been worked out in detail for a 0·2 per cent carbon steel at 450° C, as an aid to designers who may wish to use the method. Further information is given in "Behaviour of Metallic Thick-Walled Cylindrical Vessels or Tubes Subject to High Internal or External Pressures at Elevated Temperatures," by A. E. Johnson, J. Henderson, and B. Khan. Reprints of this paper, to be published in the *Proceedings of the Institution of Mechanical Engineers*, are available from NEL.

Drawing Wire at High Speed

Any increase in the maximum speeds and outputs of machines drawing high-tensile steel wire must be accompanied by a corresponding improvement in the cooling efficiency, if the loss of ductility which results from drawing at elevated temperatures is to be avoided.

Experimental tests carried out by the British Iron and Steel Research Association have shown that improvements in speed of the order of 30 per cent can be gained by preventing the formation of rust deposits on the internal surfaces of the capstans.

Further improvements may be obtained by also incorporating a new "narrow gap" capstan design that has been developed by BISRA. With this, the cooling water is passed through a narrow annular channel between the drawing ring and a stationary inner cylinder. This ensures that the water flow is turbulent, thus improving the efficiency of heat transfer.

During pilot plant trials, it has been possible to achieve a 40 per cent increase in the production rates of heavy gauge wire, with a corresponding increase of 20 per cent for finer gauges.

This design has the advantage that it can be fitted to most existing machines with relatively little modification.

The application of these techniques is not restricted to mills which require greater outputs. For example, by adopting the new design it should be possible to achieve satisfactory cooling without the use of an external air blast. This would have the advantage of obviating the unpleasant working conditions caused by pollution of the atmosphere by lime and soap powder. Alternatively, it would be possible to obtain the same output with a reduced water consumption.

Greater Accuracy for Mass Spectrometers

One of the most serious limiting factors in the accurcy of mass spectrometric measurements is the background noise. In an effort to reduce this limitation, research engineers of the United Kingdom Atomic Energy Authority at Aldermaston have developed an ion detector which, in some cases, will distinguish between the required ions and the unwanted ions which constitute a large part of the noise.

These background ions may have the same charge-to-mass ratio as the desired ions or they may be ions with a very different e/m value which reach the detector because they have been scattered or dissociated by the residual gas or walls of the spectrometer. Their elimination increases the sensitivity of the apparatus and makes it less difficult to distinguish signals due to those components of a mixture which are present only in small proportions. One application of this principle results in a very sensitive leak detector for ultra-high vacuum work.

The ion detector consists of a vacuum chamber with, inside, a thin metallic foil at a high negative potential. The thickness of the foil is such that the desired ions will penetrate and liberate secondary electrons from the back of the foil. An electron detector receives these to produce a measured signal. Unwanted ions are unable to penetrate the foil sufficiently to release secondary electrons and in this way the background signal is eliminated.

Further details of the new technique are available from the Patents Licensing Officer, UK Atomic Energy Authority, 11 Charles II Street, London SW1.

Improved Blast Furnace Efficiency

Recent experiments have shown that blast furnace performance can be improved considerably by the injection of oil. This has been demonstrated at the Ebbw Vale Works of Richard Thomas & Baldwins Limited, where the first full-scale experiments to be carried out in Great Britain were started earlier this year.

During a six months trial period, about 50 tons of oil per day were used and analysis of the results obtained showed advances in output, quality and general furnace performance. These results have been more than enough to justify retention of the technique.

Two methods of injection have been tried—with stainless-steel lances and with specially designed tuyeres. Experiments are continuing to determine the most effective technique, and further improvements are expected.

Briefly, the installation consists of small-bore feed pipes to each tuyere or lance, pumps to maintain the oil pressure, and a bulk storage, heating and circulating system.

The injection of oil in the lower zone of the furnace is said to provide a very efficient method of reducing the iron oxides of the ores to the metallic state. It also reduces the amount of prime metallurgical coke charged to the furnace.

Since coke is still an essential part of the burden, and large quantities are still needed, the new development does not mean that oil can replace coke completely. What it does mean, according to a report issued by Richard Thomas & Baldwins, is that the life of high quality coking coalfields is extended and that furnaces equipped for oil injection can operate more economically and so enable the works to be more competitive.

XUM

At Home

Frontier Home

A CARAVAN that offers the owner two double bedrooms, a kitchen and a separate living room measuring 14 ft by 14 ft 6 in must certainly be counted among the outsizes. In practice it would not normally be permitted on the roads of England, but its 10 ft width makes it legal on most roads in the United States of America. Its possibilities for use in other lands where sites are remote from civilization are of course very great.

The secret of the living room of the Frontier 200 is the inclusion of two hinged walls. During travel these fold back into the main body so that the overall width nowhere exceeds the 10 ft limit. When the site is reached, the two walls are swung out as shown in the illustrations, giving the square room of the Model 55. A slightly shorter model, the 51, has a room only 12 ft 6 in by 14 ft and a very slightly smaller main bedroom, the interior being arranged on a different plan as regards details, though the basic pattern is the same. "Swinging" the walls can be carried out by two men in less than two hours.

(Above) The secret of the Frontier 200 is the two side panels which swing out to form the living room.

(Below) Measuring 14 ft by 14½ ft, the living room has electric outlets on all four walls and will take normal furniture.

The 200 is manufactured by the Frontier Homes Corporation, of Falls City, Nebraska, USA, to the designs of Peter Muller-Munk Associates. It sells for under $7,000. The layout is intended to get away from "long corridors and harsh sight lines. The Frontier 200 provides interesting views of the interior and the sense of spaciousness mobile home owners have long demanded." How well this has been achieved can be judged from the two illustrations of the interior.

The kitchen on the right has a family size dining area and is fitted with 13½ ft of walnut finished wood cabinets with flush doors. There is a refrigerator and an electric cooker. The floor is covered with embossed inlaid linoleum. Cupboards extend above the sink on the peninsular unit and over the cooking range and refrigerator.

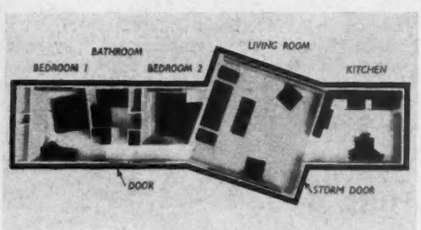
At the other end of the vehicle is the main bedroom, which has a cupboard with drawers below at the extreme end. A 54 in bed is provided and has access on both sides. Next comes the bathroom with a 54 in tub, closet, washing machine and extensive cupboard space. In the outer wall, opposite the bathroom, is an entrance door to the caravan.

In the second bedroom is a 46 in bed with drawers below and again there is access on both sides. This room has a desk instead of the vanity unit fitted in the main bedroom. Entrance is through sliding doors (which are also fitted to the bathroom) while the entrance to the main bedroom (in the Model 55) is by a swing door. In the Model 51 this is replaced by another sliding door.

The main living room has a storm door reached by steps, as can be seen in the exterior view, and is open to both the corridor on the one side and the kitchen on the other. There are windows on opposite walls and the wall run allows for the positioning of furniture to suit varying tastes. A feature absent on many permanent homes is the provision of electrical outlets on all four walls. The panelling is oak hardwood. For those occasions when informal entertaining is desired, a folding snack bar can be raised from the rear of the peninsular unit.

(Above) The kitchen is large enough to use as a dining room and has considerable cupboard space.

(Below) A model shows how long corridors have been avoided in the design, and all space well utilized.



To make the caravan suitable for prolonged habitation there is ample storage accommodation. At the end of the main bedroom there is a wardrobe and cupboard that extends the full width of the vehicle, making it almost 10 ft wide. There is a smaller cupboard reached from the second bedroom. Since the room sizes approach that of many normal homes (indeed the living room is bigger than in some) standard furniture can be used and movement is not cramped even for the larger person.

The primary intention of the Frontier 200 is for site work where a stay is of comparatively long duration. It is not really intended for moving about after one night only, although it would be quite possible to do so because of the ease of conversion from the "travelling" to the "living" form. At the majority of sites where a stay of any length is probable, some form of electricity supply is usually available. This power supply may initially have been put in for the construction work in hand but where there is a large encampment of workers, the current will also be available for the caravaners. The all-electric fitting of the Frontier 200 is consequently an added advantage.

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